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PRIORITETER



2004 -02- 0 2

Patent application

FP014.2/NO

02.02.2004

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Crank device

The present invention relates to a solution providing a crank mechanism giving an elliptical orbit to pedal or platform driven equipment.

The invention will mainly be shown and described in relation to training equipment,  
5 though it should be understood that the invention relates to all pedal driven equipment and machinery.

In the fitness industry there is a wish for training equipment, which simulate a movement of the leg and foot, as it naturally would move when walking, running and or  
10 skiing. On the market today there is equipment aiming to do so with more or less success, often called elliptical trainers or cross trainers. A typical trainer of this sort has a crank fixed with horizontal bars having platform or pedals. The bars are linked to vertical handles, which moves with the bars. The crank has or is connected to a flywheel and a brake mechanism adjusting the force driving the machine. Worth mentioning as  
15 examples are products from Tunturi, LifeFitness, Icon and Precor. There are hundreds of patents and patent applications regarding elliptical trainers and cross trainers. For example US 5792026 - Maresh and Stearns and US 6090013 - Eschenbach. These inventors have many publications regarding elliptical trainers and cross trainers but the author feels that it would be redundant to list all their patents and patent applications,  
20 not to mention all other inventors working in this field. These patents are found under International classification group A63B.

Regarding elliptical machines no publication shows the solution achieving the optimal elliptical movement as the invention in question does. The invention solves the orbit of  
25 the pedals and or platforms quite differently than the above mentioned art. Training machines creating an orbit to pedals or platforms in an elliptical shape, are often built quite big to give the wanted stride length. They also often have big and many bars linked to each other and the trainers have limited means of adjustment of the stride length and orbit of the pedals or platforms.

30

The invention uses gears or cogs to give a crank arm a rotation at the one end linked position and the outer end of the crank and pedal or platform a desired elliptical shaped



orbit. Each crank arm is divided in two parts. The outer crank arms has gears, cogs, toothed wheels, which revolves round each of a second pair of fixed gears linked together with a chain or belt. The length of the crank arm decides the size of the orbit. The length can be fixed, manually adjustable or automatically adjustable dependent on speed or desired stride length. The pedal or platform can also be fixed to the crank arm in such a position to perform a linear movement.

The invention in a typical version has a flywheel with brake means for adjusting the force needed driving the crank arms. This is preferred incorporated in a training machine, which will compete with the existing elliptical trainers or cross trainers. This kind of training machine can have a number of features as adjustable stride length and handles for arm movement.

The invention can also be used in a machine for creating force and or movement. The invention placed in a bicycle can replace the conventional crank. As the length of the crank arms change through a rotation the orientation of the ellipse is made so that the crank arms longest stride are where the force on the pedals is highest.

This application seeks priority of the inventors applications 20035785 and 20040138.

Further inventive steps are disclosed in the claims.

The technical characteristics of the invention will be described with reference to accompanying drawings, which illustrates preferred embodiments of the invention by example and in which:

25

Fig. 1a-c show a side view, top view and a front view of the first embodiment

Fig. 2 shows a perspective view of the first embodiment

Fig. 3a-d show side and front view and detail views of the flywheel and drive assembly within the first embodiment.

Fig. 4 shows a perspective view of the flywheel and drive assembly within the first embodiment.

Fig. 5a-b show a variation of flywheel connection.

5

Fig. 6a-c show the elliptical orbit of the pedals given by the first embodiment of the invention.

Fig. 7a-h show the movement of the crank during a full orbit according to the first  
10 embodiment.

Fig. 8 illustrates the principle according to the inventions first embodiment.

Fig. 9 illustrates a variation according to the inventions first embodiment.

15

Fig. 10 shows pedal or platform held in a horizontal position through a full elliptic orbit according to the invention second embodiment.

Fig. 11a-d show schematically transmission variations of the second embodiment.

20

Fig. 12a-b show a side view and a front view of the preferred second embodiment.

Fig. 13 shows a side perspective of the preferred second embodiment.

25 Fig. 14a-b show means for lengthening of crank arms.

Fig. 15a-b show a solution as a combination of the invention shown on figures 11 and  
14

30 Fig. 16 shows a flowchart of adjustable automatic stride control.

Fig. 17a-c show platform with tilt motion.

Fig. 18a-b show pedal with tilt motion.

Fig. 19a-c show a training machine utilizing the invention with platforms and fixed  
5 handlebars,

Fig. 20a-c show a training machine utilizing the invention with platforms and moving handles.

10 Fig. 21a-c show crank device for adjustments with reference to the second embodiment.

Fig. 22a-c show movement of crank arm and platform.

Fig. 23a-d show schematically orbit and tracks for pedal and platform motion.  
15

Fig. 24 shows a flowchart of adjustment of track and orbit.

Fig. 25a-b show training machine with crank device and moving handles.

20 Fig. 26 shows a training machine with crank device.

Fig. 27 shows training machine with reclining seat and crank device.

Fig. 28 shows a bicycle utilizing the invention.  
25

Fig. 29a-b show an embodiment of the crank device with short outer crank arms especially designed for power transmission.

Fig 30 shows perspective view of crank device.  
30

Fig 31a-c show the motion of the crank arms and pedals.

Fig. 32 shows a crank device as part of drive chain on a bicycle.

Fig. 33a-b show a crank device with inner gear transmission.

5 Fig. 34 shows perspective view of crank device according to fig. 33.

Fig. 35a-b show the motion of the crank device according to fig. 33-34.

10 Fig. 1 and 2 show the assembly of the crank assembly according to the invention. On a frame 1 is mounted a crank assembly comprising a pair of two-part crank arms 2 and 3 rotate ably linked together at 4 and 5. The inner crank arms 6 and 7 are fixed together through an axle 8 (not shown). The outer crank arms 10 and 11 are fixed through axles 12 and 13 to gears 14 and 15 rotate ably through the inner crank arms. To the frame is  
15 fixed non-rotate able gears 16 and 17. The ratio between gears 12-13 and 16-17 is 1:2. Chains 18 and 19 connects the gears. It should be understood that the chain could be replaced by a belt, toothed belt and cogs. The end portions of the outer cranks have pedals 20 and 21. To the axle 8 is fixed a wheel 22, which rotates when the crank is set in motion. As shown in fig. 3-4 a wheel 24 runs on the inside of wheel 22. The wheel 24  
20 is connected to a wheel 25 via an axle 26 through a tension block 27 fixed to the frame. The tension of the wheel 24 to wheel 22 is adjusted by screws on the tension block. Round the axle 8 is freely rotate ably mounted a flywheel 30. A belt 31 connects the flywheel to wheel 25. As the crank arms are set in motion the flywheel is set in motion. The ratio between wheel 22 and 24 is in the area of 10-(3-1), but can be varied  
25 depending on the size and wanted speed of the flywheel. As shown in fig. 5a-b the flywheel can also be located outside the crank assembly. The flywheel will have means of braking. This is done using known art, here indicated on fig. 4 with number 34 where an electro-magnetic brake device is mounted. Other brake devices include using a variable tension belt round the flywheel or some kind of brake shoes.

30

The motion of the crank arms is shown in figures 6 and 7. As shown in fig. 6 the result of one rotation will give an elliptic orbit 40 at the pedal positions. The length of the

outer crank arm, or fixing point of the pedal decides the size of travel as shown on fig. 6b where the fixing points for the pedals are indicated at 41 and 42. When setting the pedals and crank arms in motion, as indicated by arrow 48 on fig. 7 the fixed end of the outer crank arm will travel as indicated by arrow 49. This happens as a result of a  
 5 rotating movement of the gears fastened to the other crank arm and their travel on the chains revolving round the fixed gears. The figures 7a-7h show the travel of the crank arms at 45° intervals through a full 360 orbit.

Turning back to fig. 6 the elliptic orbit or linear track of the pedals in motion are the  
 10 result of the wheel diameter (Wd, inner crank diameter), and arm radius (Ar, length from turning point to pedal fixing point of inner crank arm). Fig. 6c show the crank device schematically where Ol is length of orbit, Ar is arm radius, Oh is height of orbit and Wd is wheel diameter. The formula:

- $Ol = Wd + 2Ar$
- 15 -  $Oh = 2Ar - Wd$

If Wd is 300mm and Ar is 175mm we get  $Ol = 300mm + 2 \times 175mm = 650mm$  and  $Oh = 2 \times 175mm - 300 = 50mm$ . Placing pedals or platforms on the outer crank arm along lines 44 and 45 and holes 41- 42 gives them an elliptical orbital movement, until point  
 47 where a circular movement is achieved. Placing the pedals or platforms at centre  
 20 point 43 of the outer crank arms gives a flat track 46. The movement of the outer crank arms are shown in fig. 6c where 43'-43''' indicates the centre point of the other crank arms. We see that Wd of 300mm and Ar of 150 give a flat track ( $1\frac{1}{2} Wd = Ar$ ). This can be utilized in a training machine for simulating a skiing motion.

25 The direction of the orbit the pedals perform when set in motion is also dependent on the length between the crank arms. When the outer crank arms are shorter than the inner crank arms and which when outer crank arms are set in motion gives the pedals an elliptical orbit in the same direction of the inner crank arms and axle. When the outer crank arms are longer than the inner crank arms and which when outer crank arms are  
 30 set in motion gives the pedals an elliptical orbit in the opposite direction of the inner crank arms and axle. The definition being;  $Ar > \frac{1}{2} Wd$  the pedals motion will be in the

opposite direction of the main crank axle and  $A_r < \frac{1}{2} W_d$  the pedals motion will be in the same direction of the main crank axle.

5 The first embodiment of the invention uses a chain 50 to transfer the crank arms 51 the desired motion as the principle fig. 8 illustrates, showing fixed gear 52 and the rotating gear 53 fixed to crank arm. It should be understood that the chain could be replaced by a belt driven system.

10 The motion can also be achieved by using gears, which directly interact as illustrated in fig. 9, which forms a variation of the invention. Gear 60 is fixed. Moving the crank arm 61 as indicated by arrow 62, rotates gear 63, which is fixed to the crank arm, and in turn rotates gear 64, which then revolves around gear 61. For the outer crank arm to revolve 360 degrees, the ratio between the inner gear and the outer gear must be 2:1.

15 Having the invention in a training machine which to use in a running position, may demand pedals, or platforms to stay in a horizontal position or other wanted angle during a full rotation of the crank. Fig. 10 shows pedal or platform 70 through a full orbit staying horizontal in all positions. The outer crank arm 75 have a first gear 77 attached to the pedal/platform axle which is connected to a second gear 78 attached to the outer crank axle through a chain 76. Gear 78 is connected through an axle to a gear 80 on the inside of the crank arms 75 and 79. Gear 80 is connected to a gear 82, which is fixed to the frame 84, through a chain 85. The ratio between the gears 77, 78, 80 and 82 is 1:1 as suggested in fig. 11a -b. This keeps the platform or pedal 70 at the same angle independent of the rotations of the crank arms. As shown in fig. 11c-d the chain drive is replaced by an axle 90 with conic gears 91 and 92 which connects with gear on pedal axle 94 which distributes a 1:1 rotation to the pedal axle from gear 95 connected through an axle and gears as shown in fig. 11a-b.

25

Fig. 12-13 show a second embodiment within the invention, which gives pedals or platforms a controlled angle through a rotation of the crank arms. The solution gives the same result as solution shown in fig. 11, but has two fixing positions for pedal or platform. Fig. 12 does however only show the one side of the construction.

30

As described for the embodiment shown in fig. 1 and 2 the crank device has an outer crank arm rotational fixed to an inner crank arm 101. A gear 103 is stationary fixed to the frame 105, which is linked to gear 106 through chain 108. Gear 106 is fixed to outer crank arm 100 via an axle rotational through inner crank arm 106. Ratio between gear 103 and 106 is 2:1. As shown in fig. 7 will movement of the outer crank arm turn gear 106 and move the fixing point between the two crank arms 110, on the chain round the fixed gear 103. A gear 112 is rotational fixed to the outer crank arm, but stationary fixed to the inner crank arm. Movement between the crank arms will make gear 112 rotate relative to the outer crank arm. This rotation is transferred to a gear 114 rotational fixed to the outer crank arm through a chain 115. The ratio between gears 112 to 114 is 1:2. Fixed in centre of gear 114 is gear 120 with a fixing point 121 for attachment of pedal or platform. The rotation of gear 114 makes gear 120 and fixed pedal or platform (not shown) rotate independently of the crank arms. It should be understood that the ratio shown in this embodiment is made for keeping pedal or platform in one position through a full rotation of the cranks, and changing the ratios will angle the pedal or platform differently. To the outer crank arm a second fixing point 123 for pedal or platform is placed in the centre of gear 122 rotational relative to outer crank arm. Between gear 120 and gear 122 is a chain 124, which in ratio 1:1 transfers rotation from gear 120 to 122 and attached pedal or platform. This gives this gear device two fixing points for pedals or platforms, fixing point 121 giving a flat working track as explained relative to fig. 6.

Fig. 13 show in perspective the crank device described accordingly in fig. 12.

In a training machine utilizing the invention an adjustment of the stride length is desirable. This can be done as explained above in connection with fig. 6, but methods achieving this during a motion will be explained using fig. 14. Fig. 14 and 15 show how the crank arm can be made for both having controlled pedal angle and adjustment of crank arm length. Fig. 14a show the outer crank arms 130 and 131 with pedals 132 and 133 fixed to means for adjusting the length of the crank arms. The means illustrated are cylinders 134 and 135. Using pressurized oil and return springs the cylinders can expand and extract giving a variation of the stride length 136. Having sensors for

measuring the speed during rotation of the crank coupled to means for signalling to a pump, the oil pressure can be increased to give a stride dependent on speed. Short stride for low speed and long stride at high speed. The mechanics of this is not in detail shown on the figure but should be of known art to anyone skilled in the art.

- 5 Variation of the stride length is also possible using treaded bolts which when given a rotation moves the outer ends of the crank arms. As illustrated in fig. 11b, the bolts 138 and 139 can be fitted with electric engines 140 and 141, which can rotate the bolts when given the wanted signal. A sensor measures the speed of the crank arms signalling the engines for executing wanted length of the cranks.

10

Fig. 15a-b shows a variation of adjustment of crank length for a crank device as shown in fig. 11b-c. The outer crank arm 150 consists of two parts 151 and 152 which when slid relative to each other as indicated by arrow 153, adjusts the length of the crank arm. An axle 155 with gears as shown in fig. 11 is telescopic and will adjust with the length

15 of the crank.

- Fig. 16 shows a flow chart illustrating a system for automatic, or user defined stride control and adjustment. Speed of the cranks can be measured by a sensor 160 for example directly on the crank axle, axle mounted wheel, flywheel or other parts rotating as result of crank axle rotation, illustrated by 161.
- 20

The sensor sends signals to a microprocessor or CPU 162, which is programmed, to means for adjusting cranks 163 and 164. Numbers 165 and 166 indicates engines or pumps. Numbers 167 and 168 indicates sensors, which measures the length of the cranks. Means for operating is provided in form of button clusters with display or of a

25 touchscreen, marked 169. Run by a program in the CPU can display choices on a screen, for example adjustment of the stride 170 or automatic adjustment of stride dependent on speed 171.

- The crank device will have means for supporting the foot of a user. Depending on what
- 30 type of training machine the crank device is mounted in, either platforms or pedals are fixed to the crank arms. To gain proprioceptive training flexible platforms or pedals should be mounted on the crank device.



Fig. 17 shows a type of platform, which has means of tilting. An upper platform part 180 is fixed to a frame 181 through axles 183 and 184. The frame has an axle or bolt 185 for fixing to crank arms. As illustrated in fig. 17c the platforms upper part is tilt able transverse to the axle 185. The platforms upper part is made firm through twisting  
5 a bolt 188 parallel to the axle 185, the bolt having the same dimension as the gap between the upper platform part and the frame.

Fig. 18 shows a pedal with tilt motion. The pedal body 190 has an axle 191 which to fasten to a crank arm. To the pedal body a footrest 192 is tilt able fixed 90° to axle 191.  
10 This gives a pedal with one traditional stable pedal side 193 and an unstable tilt able side 194.

As mentioned above the invention may be utilized in a number of pedal driven machines. Fig. 19 shows a training machine utilizing the invention with platforms 200  
15 and 201 and fixed handles 203 and 204. The crank device 205 shown is described according to fig. 12 but it should be understood the any of the embodiments or variations thereof, shown in this application could be utilized in such a machine. This machine is a compact unit and the frame is constructed so to fold, fig. 19d, and thereby save space when in storage.

20 Fig. 20a-c show a training machine utilizing the invention with platforms and moving handles. The figure is purely schematically and shows how prior art regarding moving handles can be incorporated with the crank devices according the invention. The handles 210 and 211 are hinged to bars 212 and 213, which are linked to the crank  
25 device through axles. Details are not shown, as the principle should be known to any familiar with the art. It should be emphasized that the flywheel can be placed outside the crank and be linked to the rotating crank axle through a belt or chain as indicated in fig. 5. Fig. 20c illustrates how one can achieve an "uphill or downhill" training experience by changing the angle 215 of the cranks orbit. By adjusting the crank device's 214 angle  
30 on the training machine frame the elliptical orbit can be adjusted.

As shown in fig. 20 the angle of the orbit and stride track can be adjusted by tilting the whole crank device relative to the frame of the training machine. This does however also tilt the fitted platforms. As will be shown in the following figures the angle of the orbit and track can be adjusted relative to the frame of the crank device and still keeping fitted platforms at a horizontal level. Fig. 21a-b shows the embodiment related to fig. 12-13 where the stationary gear 220 is adjustable. The gear 220 is fixed to the frame 222 in such a matter that is can be loosened from the frame, rotated and fixed back to the frame. A rotation of the gear 220, as indicated by arrow 224, will make gear 223 turn and move the outer crank arm 228 as indicated by arrow 225. The fixing points 230 and 231 will keep the original position, as the inner crank arm 232 still is stationary. Gear 220 is then fastened relative to the frame and the further motion of the crank arms will then work as explained earlier, but with the orbit at an offset angle to the horizontal plane.

Fig. 22 shows platform 236 connected to the outer crank arm outer fixing point 231. Fig. 22a show a folded position of the crank arms. A 45° rotation of the crank arms relative to gear 220 is shown in fig. 22b, and another 45° rotation of the crank arms is shown in fig. 22c. The platform will stay in the same position relative to the frame through a full rotation as explained in relation to figures 11-13.

Fig. 23a shows different orbits and tracks possible from using the crank device according to the invention explained above, 250 indicating orbits, and 251 indicating straight track motion. The orbit and track size is explained with reference to fig. 6. Fig. 23b show orbit of platforms 254 in a horizontal orientation. Fig. 23a show orbit in an angle relative to a horizontal plane. Note the upward orientation of the platforms, which when used in a training machine will give a climb ore step sensation for the user. Fig. 23d show platforms oriented along a line which gives a skiing simulation used in a training machine. All orientations shown in figures 23a-d can be achieved in the one training machine when utilizing the invention according to embodiment explained relative to fig 21-22.

Turning back to fig 21, there is indicated by number 227 an adjustment device, preferably a servo engine, which when activated can turn the gear 220 to fix the desired angle of the orbit or track. Having such an automated adjustment device incorporated in the crank device, a user is able to adjust the angle of stride when using a training machine utilizing the invention. Fig. 24 show a flowchart of the main components of an automated adjustment system in a training machine, which when combining with system shown and explained with fig. 16, will give a user full control of the stride, meaning orbit and stride size and angle, during a workout. A mechanical working adjustment device, as an electric motor servo 260, as used as an example in this scenario, is connected to the fixed gear 262. A sensor 263 will monitor the movement of the motor or gear 262 and give signals to a CPU 264 which in turn is connected with a control device 265 having screen, touchscreen or display 266 with user means 267 for input and control. The CPU is programmed to show the adjustments made by the user on the screen/display. The adjustments made or chosen by the user from the control device is processed by the CPU which signals a motor controller 270 which sends the correct signals and power to the motors for turning gear and set cranks 271 272 accordingly.

Fig. 25 shows a training machine utilizing the invention. The training machine has handles, 280 and 281, which are hinged with rods 282 and 283. The rods are connected with the crank device between the two crank arm constructions. This is not shown in the figure, but is done as a typical crank solution known to anyone familiar to the art. The handles moves back and forth as indicated by arrow 285, and transverse with the platform movement as one would do when skiing and which is a typical movement on elliptical trainers.

Fig. 26 shows the crank device 290 utilized in a training machine of an ergometer type or indoor training bicycle.

Fig. 27 shows the crank device 292 utilized in a training machine of a reclined ergometer type.

Fig. 28 a-b show a road going bike utilizing the invention. The crank device according to the inventions first embodiment replaces the common bicycle crank. Fig. 28a show the crank device placed so that the crank arms 301 and 302 at their longest position points at about 45 degrees up and forward. This gives a rider a powerful weight arm when pedalling forward and down. The orientation shown on fig. 28b gives a long downward stroke along the flattest part of the elliptic orbit. To gain the right direction of drive to the rear wheels an extra gear 303 is fitted to change the direction of the inner crank axle. As shown in for example fig. 7, the direction of the pedals move opposite of the inner crank axle. The following will show how shortening the length of the outer crank arms affects the motion of the crank axle when pedalling.

Fig. 29 shows a crank device, which works as shown earlier in figures 1-8. The outer crank arms 310 and 311 are short relative to the inner crank arms 312 and 313. This gives the pedals 314 – 315 an elliptical orbit, as illustrated by 316, but the direction is the same as the crank axle 317. A gear or cog 318 is fixed to the crank axle and can be attached to a chain 320 to drive gears 319 for example on a bike or other crank driven machinery. Arrows 321 and 322 show direction of pedal travel, arrow 324 show direction of drive chain. Understanding the crank device relative to fig. 6, the diameter (Wd) of the circle is made from the inner crank arm dependent of the arm length and the orbit of the pedals are dependent on the relation between Wd and the length of the outer crank arm. At one point the length of the outer crank arms gives a flat travel of the pedals. Making the outer crank arms shorter than the point where a flat travel is achieved, the elliptical orbit is again present, but the direction of travel for the pedals have turned even though the direction of the outer crank arms are the same. This makes this embodiment of the crank device suitable for using directly on a bicycle or other similar machinery. Fig 30 shows perspective view of the crank device. Fig. 31a-c show the motion of the crank device as shown in figures 29-30. Fig. 32 show crank device 328 on bicycle.

The crank device according to the invention may work with gears/cogs, connected with chains/belts, or directly geared. Fig. 32 show an embodiment of the invention where the outer crank arms 330 – 331 have gears 332 and 333 which are directly connected to a

fixed gears 334 and 335 which are toothed on the inside. 336 and 337 are the inner crank arms, and 338 and 339 are the outer crank arms. The motion of the crank arms are the same as for the embodiments shown in figures 1-9. Illustrated by 329 is a natural place for a flywheel or a drive gear or cog, which will be fixed to the main crank axle.

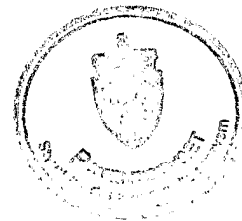
- 5 Fig 34a-b show that when pedal and crank arm 340 is moved in direction of arrow 341, the inner crank arm 342 will move counterwise indicated by arrow 343 as the gear 344 moves on gear 345.

- As described earlier together with figures 14-16 an adjustment of the elliptical orbit and  
10 the stride length for the crank device is desirable, especially when used in a training machine. Fig. 36 shows a solution to how the length of the outer crank arm can be adjusted. The adjustment can be activated while the crank is in motion.

- In the claims "pedal" or "pedal like" should be understood as all kind of pedals,  
15 platforms and other devices for apparatus made for placing feet and stepping on or otherwise moving the feet for turning a crank.

- The invention described can be subject to modification and variations without thereby departing from the scope of the inventive concept. Moreover, all the details of the  
20 invention may be substituted by technically equivalent elements.

25



30

Claims:

1.

A crank device for use on a pedal like driven exercise machinery such as training  
5 equipment like elliptical machines, cross trainers, steppers, ergometer bikes, spinning  
bikes and road going bikes, where the crank arms each comprise of at least two parts,  
characterized in that the travel of the pedals form an elliptic orbit as the outer parts of  
the crank arms are rotate able counter wise of the inner parts of the crank arms.

(Fig. 1-2, 6-9, 12-13, 31)

10

2.

A crank device for use on a pedal like driven machinery where the crank arms each  
comprise of at least two parts, characterized in that the travel of the pedals form an  
elliptic orbit as the outer parts of the crank arms are rotate able counter wise of the inner  
15 parts of the crank arms.

(Fig. 1-2, 6-9, 12-13, 29-31)

3.

A crank device according to claim 1 and 2, characterized in that the inner crank arms  
20 are fixed together through an axle and the outer crank arms are fixed through axles to a  
first pair of gears rotate ably through the inner crank arms, and where the inner crank  
arms axle runs freely through a second pair of gears fixed non rotate able to a frame; the  
said first pair of gears connected to the second pair of gears through a pair of chains or  
belts making the said first pair of gears orbit the said second pair of gears when the  
25 outer crank arms are set in motion.

(Fig. 1-2, 6-8, 12-13, 29-31)

4.

A crank device according to claim 1 and 2, characterized in that in that the inner crank  
30 arms are fixed together through an axle and the outer crank arms are fixed through axles  
to a first pair of gears rotate ably through the inner crank arms, and where the inner  
crank arms axle runs freely through a second pair of gears fixed non rotate able to a

frame; the said first pair of gears linked/connected to the second pair of gears through a third pair of gears placed between the first and second pair of gears, making the said first pair of gears orbit the said second pair of gears when the outer crank arms are set in motion.

5 (Fig. 9)

5.

A crank device according to claim 1 and 2, characterized in that in that the inner crank arms are fixed together through an axle and the outer crank arms are fixed through axles  
10 to a first pair of gears rotate ably through the inner crank arms, and where the inner crank arms axle runs freely through a second pair of gears fixed non rotate able to a frame; the said first pair of gears connected to the toothed inside of the second pair of gears making the said first pair of gears orbit inside the said second pair of gears when the outer crank arms are set in motion.

15 (Fig. 33-35)

6.

A crank device according to claim 1-5, characterized in that the inner and outer crank arms fold parallel at two points of one rotation and stretches in line at two other  
20 positions of the rotation forming an elliptic orbit of the pedal end of the outer crank arms.

7.

A crank device according to claims 1-6, characterized in that the ratio between the first  
25 gears and second gears are 1:2.

8.

A crank device according to claim 1-7, characterized in that the length of the outer crank arms relative to the length of the inner crank arms defines the size, shape and  
30 direction of the pedals orbit when set in motion.

(Fig. 6)

9.

A crank device according to claim 8, characterized in that the size of orbit is defined as the relation between orbit length= $O_l$  and orbit height =  $O_h$  and where length of inner crank arm = wheel diameter =  $W_d$  and outer crank arm = Arm radius, giving the definition of orbit size:  $O_l = W_d + 2Ar$  and  $O_h = 2Ar - W_d$ .

10.

A crank device according to claim 8, characterized in that when the outer crank arms are shorter than the inner crank arms and which when outer crank arms are set in motion gives the pedals an elliptical orbit in the same direction of the inner crank arms and axle and when the outer crank arms are longer than the inner crank arms and which when outer crank arms are set in motion gives the pedals an elliptical orbit in the opposite direction of the inner crank arms and axle, defined as when  $Ar > \frac{1}{2} W_d$  the pedals motion will be in the opposite direction of the main crank axle and when  $Ar < \frac{1}{2} W_d$  the pedals motion will be in the same direction of the main crank axle.

11.

A crank device according to claim 8, characterized in that when  $Ar = \frac{1}{2} W_d$  the pedals motion will follow a straight line.

12.

A crank device according to claim 1-5, characterized in that outer crank arm has pedals or platforms with a tilt motion transverse to the axis of pedal or platform rotation, and where the tilt motion is adjustable.

(Fig. 17-18)

13.

A crank device according to claim 1-5, characterized in that the device is mounted on a road going bike where at least one gear connected to the main axle between the crank arms drives the rear wheel through means of a chain or belt and that the orientation of the crank device work area is done for the maximum transmission of power from the user. (Fig. 28, 32)





**S u m m a r y:**

A crank device for use on a pedal like driven exercise machinery such as training equipment like elliptical machines, cross trainers, ergometer bikes, spinning bikes and road going bikes, where the crank arms each comprise of two parts which in motion  
5 gives the pedals a travel in an elliptic orbit as the outer parts of the crank arms are rotate  
able counter wise of the inner parts of the crank arms.

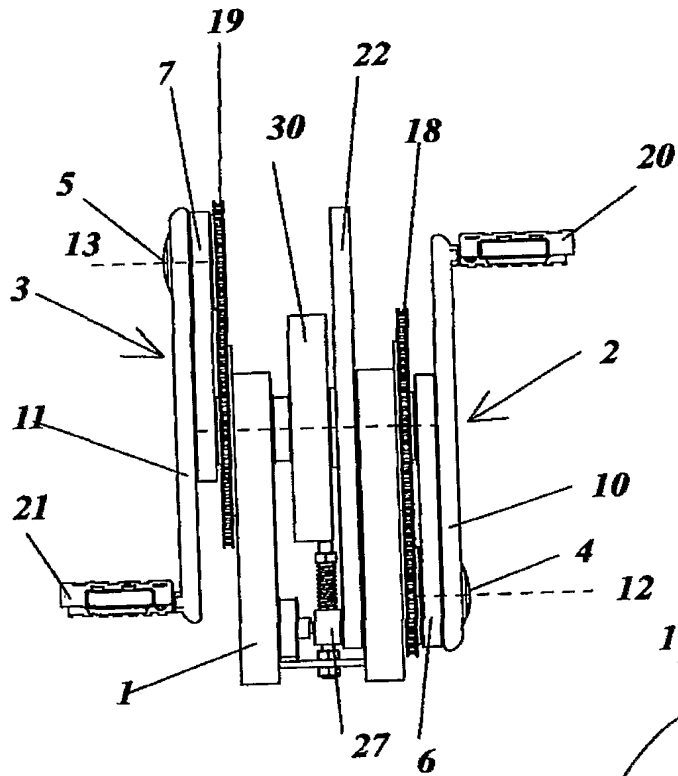
(Fig. 30)

10

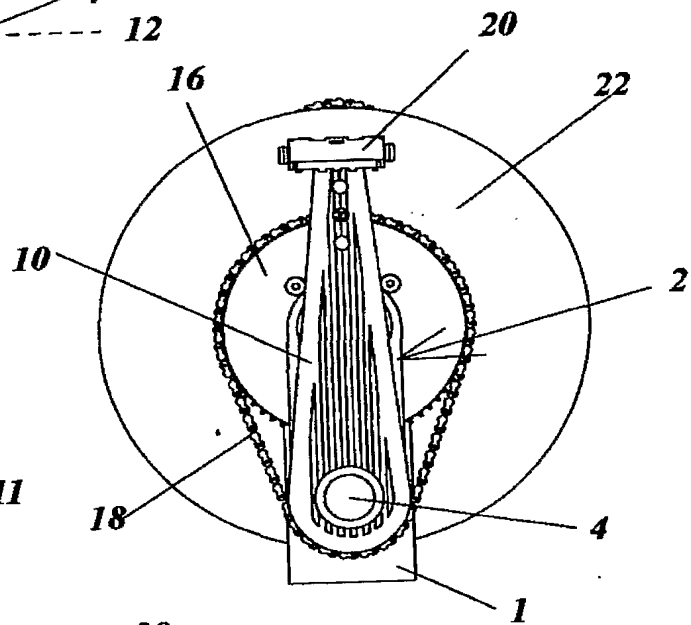
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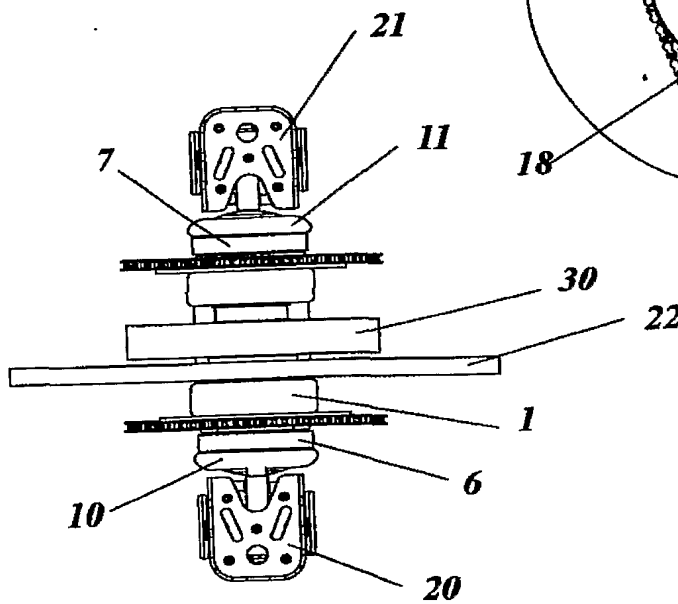
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**Fig. 1a**



**Fig. 1b**



**Fig. 1c**



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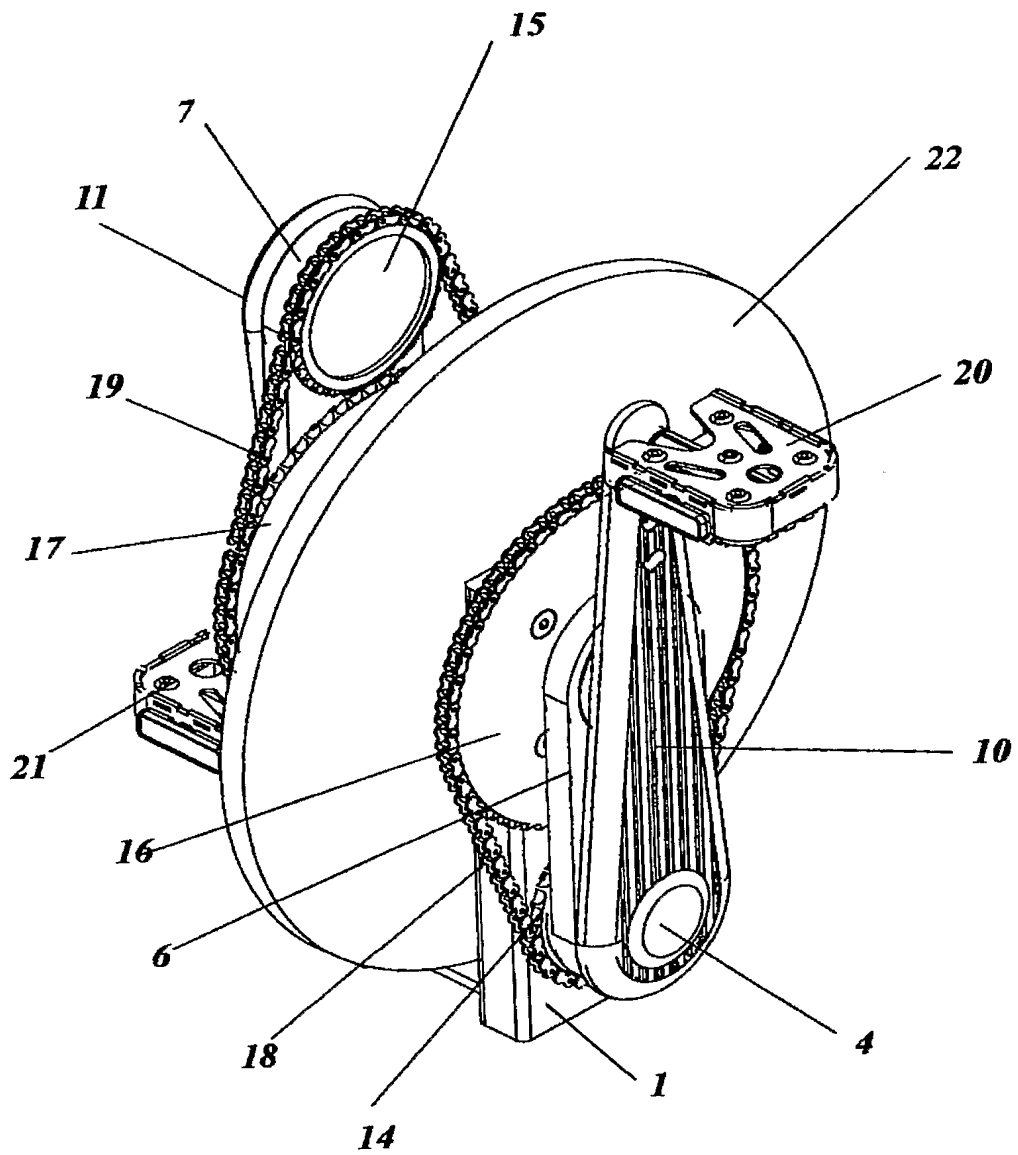
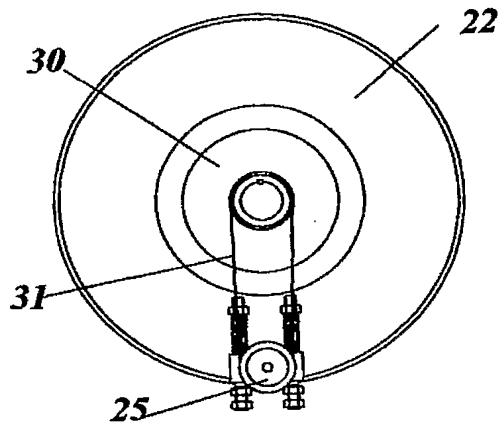


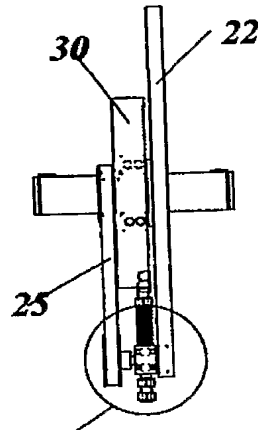
Fig. 2



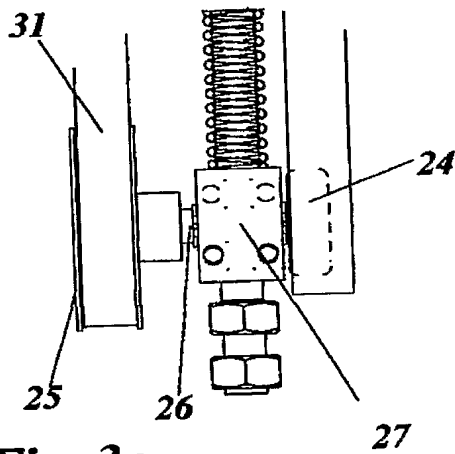
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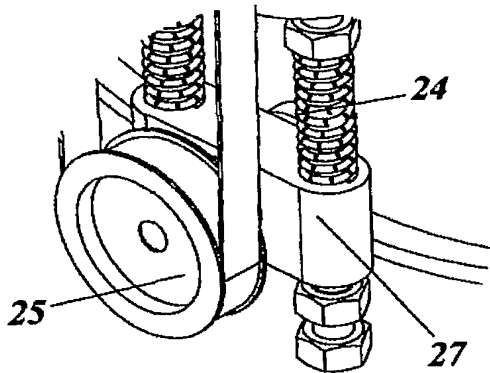
**Fig. 3a**



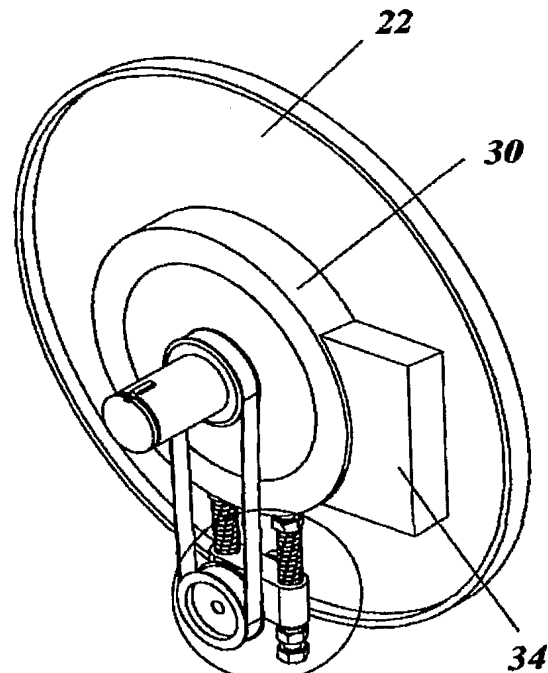
**Fig. 3b**



**Fig. 3c**



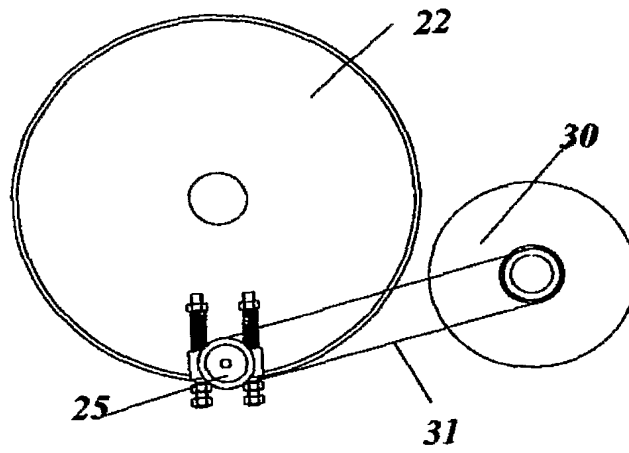
**Fig. 3d**



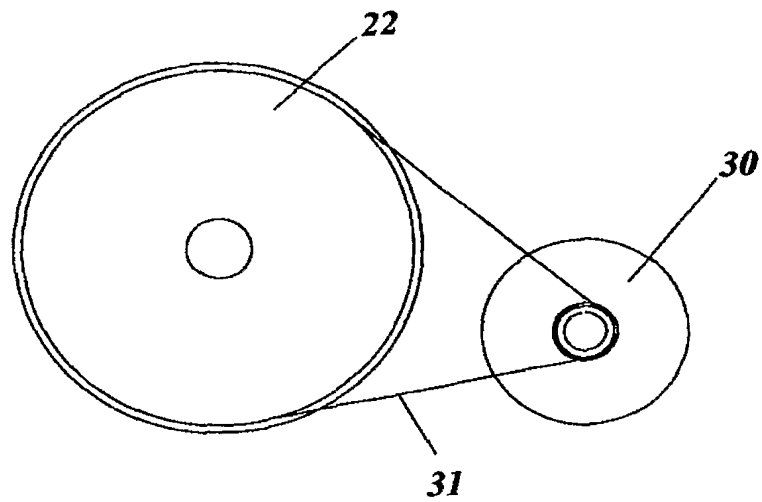
**Fig. 4**



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**Fig. 5a**



**Fig. 5b**



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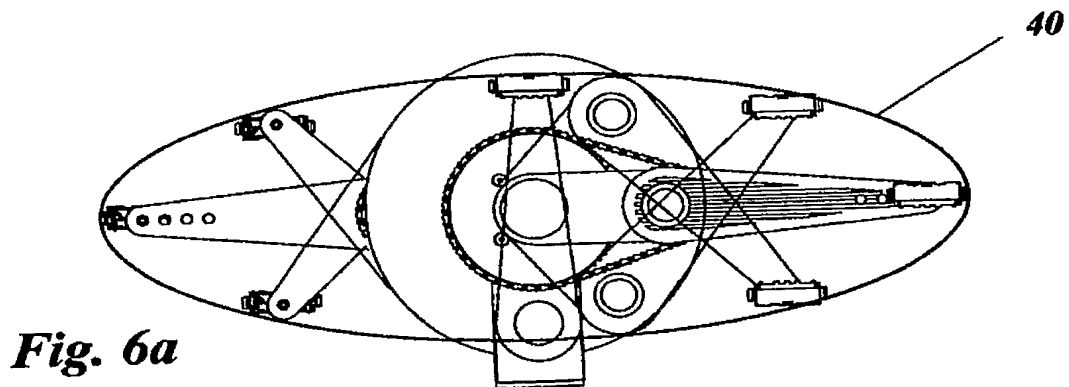


Fig. 6a

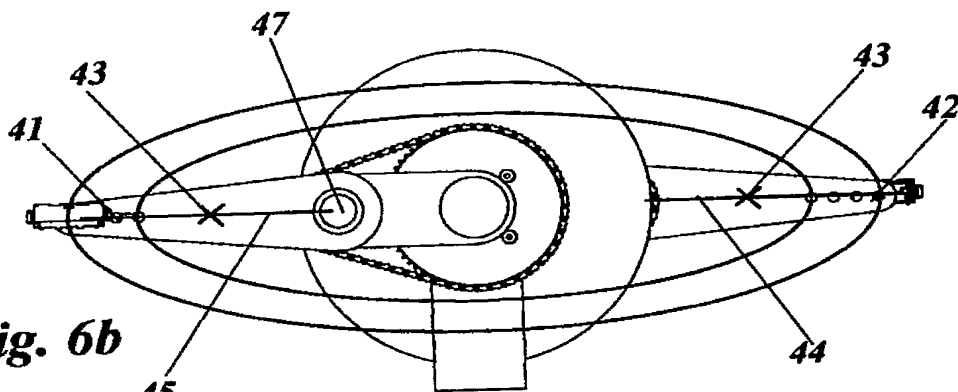


Fig. 6b

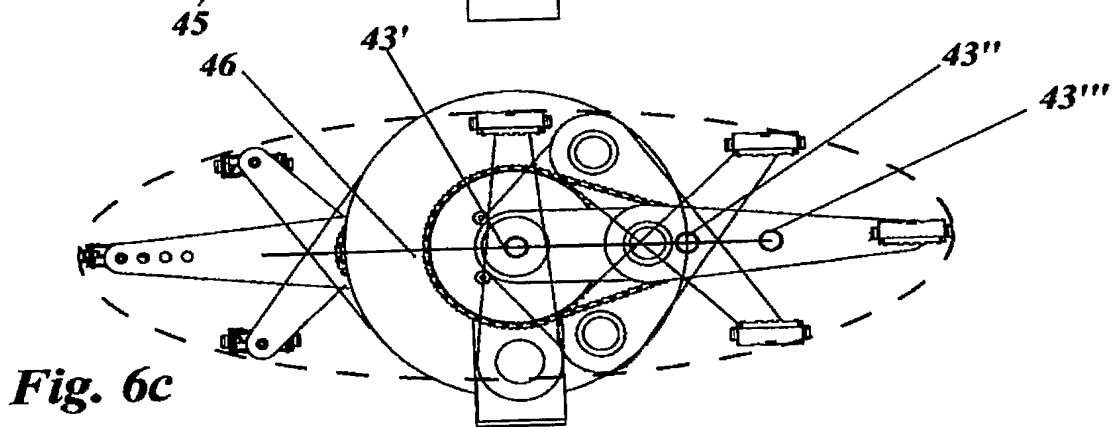


Fig. 6c

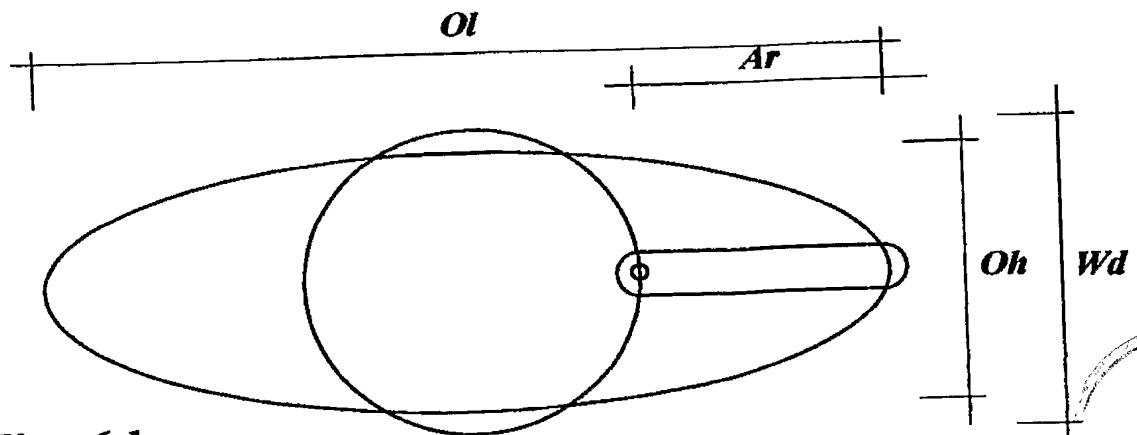
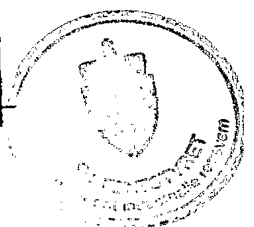
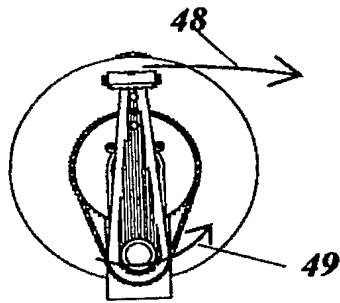


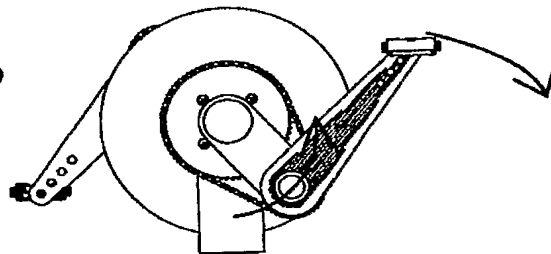
Fig. 6d



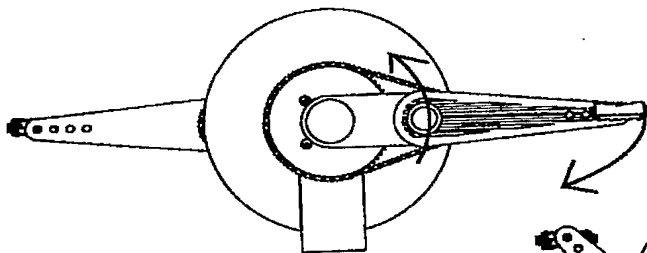
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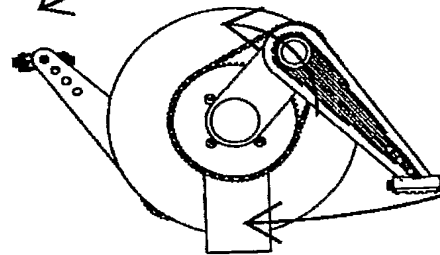
**Fig. 7a**



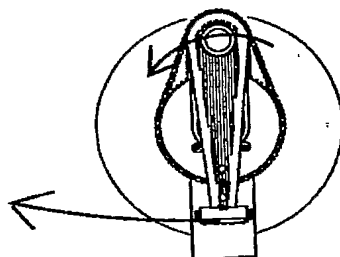
**Fig. 7b**



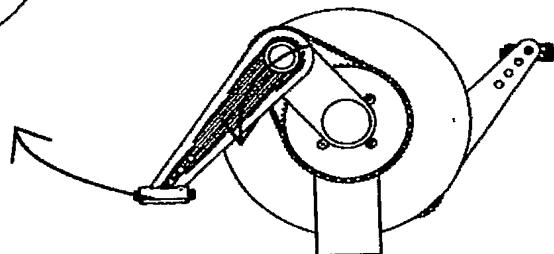
**Fig. 7c**



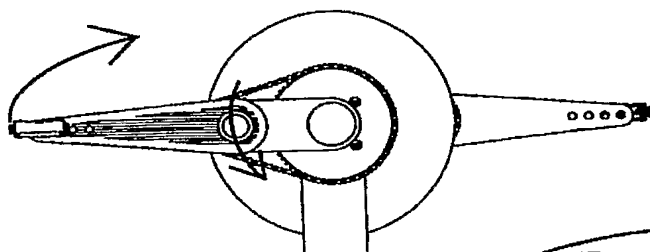
**Fig. 7d**



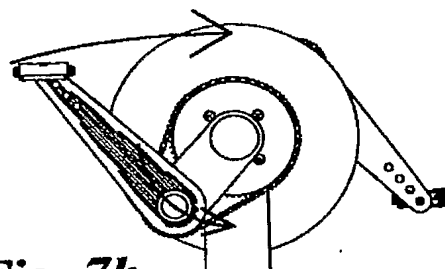
**Fig. 7e**



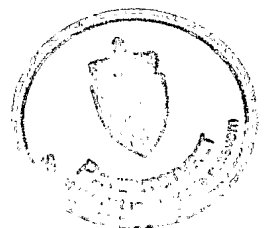
**Fig. 7f**



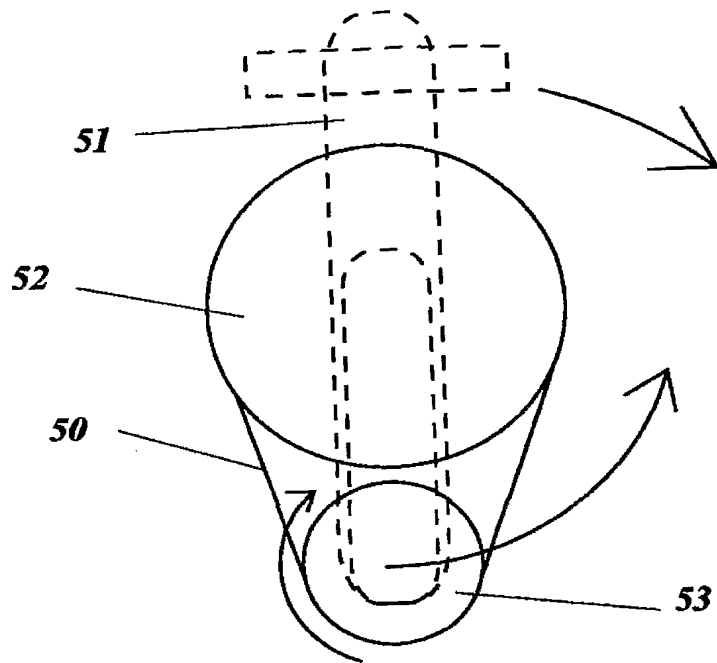
**Fig. 7g**



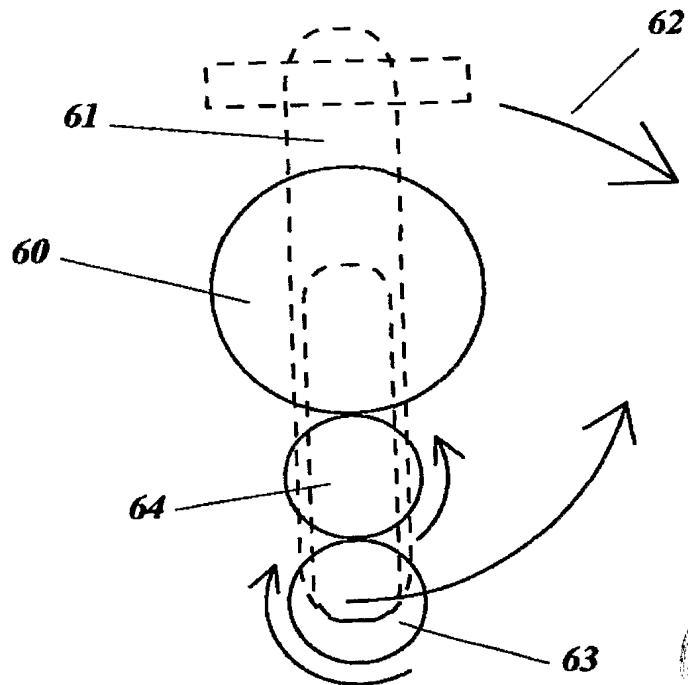
**Fig. 7h**



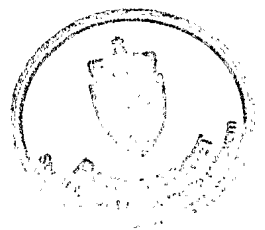
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**Fig. 8**

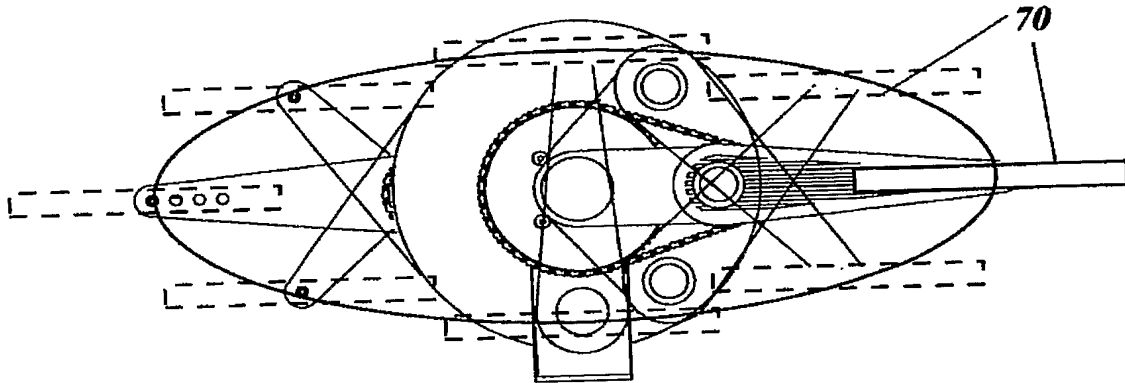


**Fig. 9**

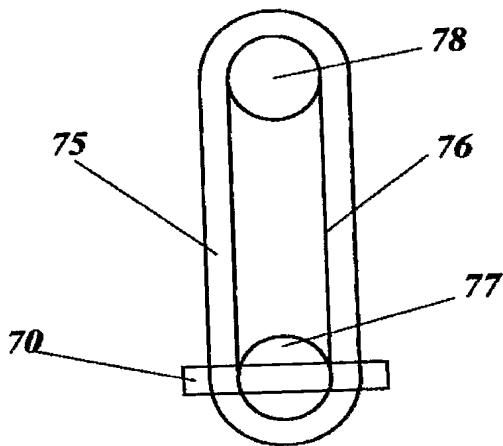




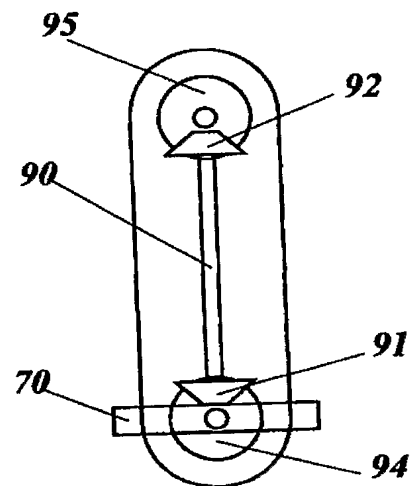
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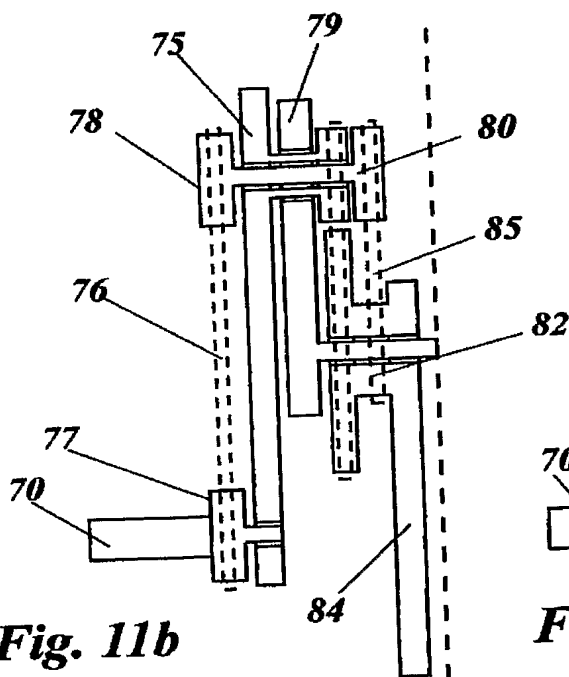
**Fig. 10**



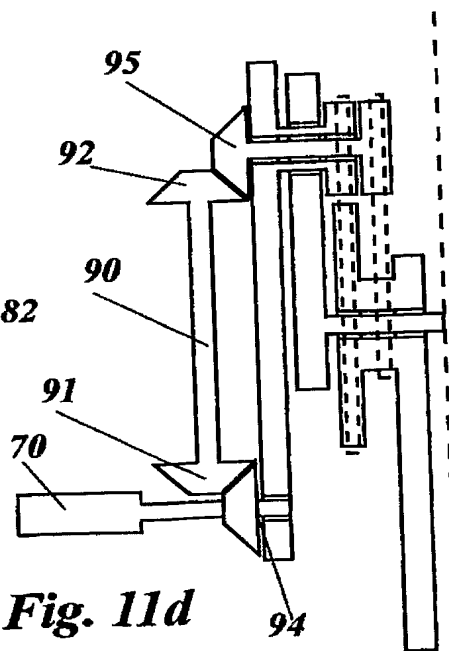
**Fig. 11a**



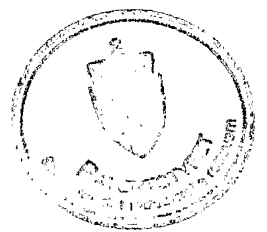
**Fig. 11c**



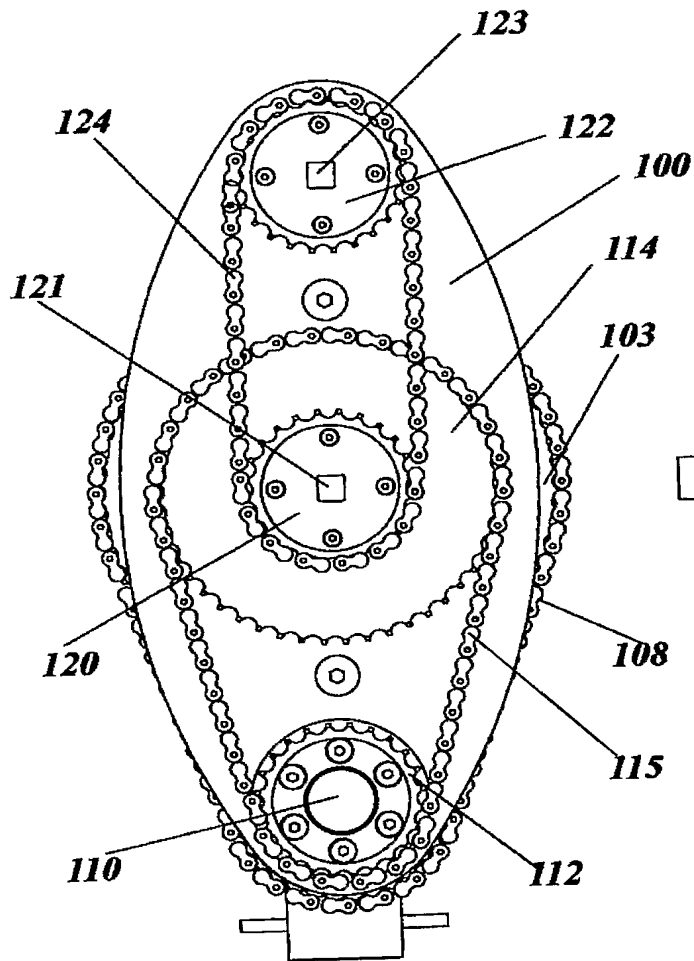
**Fig. 11b**



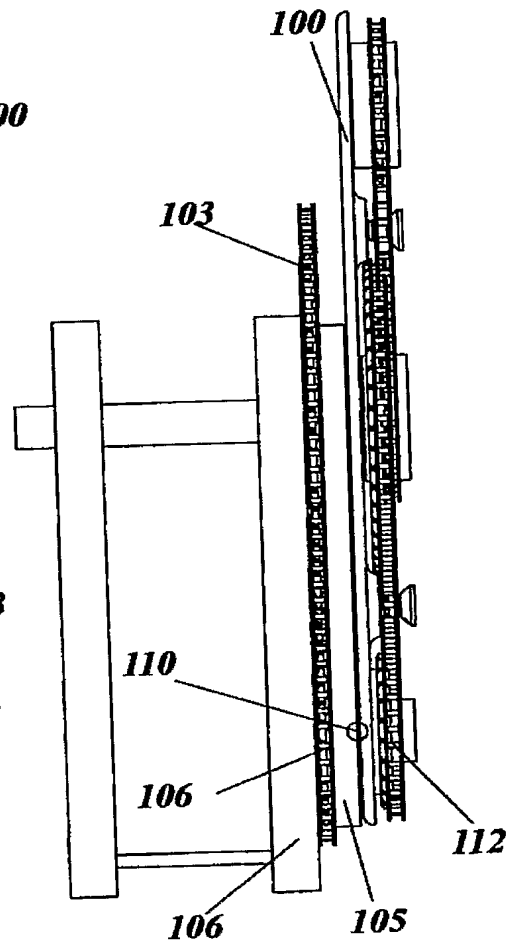
**Fig. 11d**



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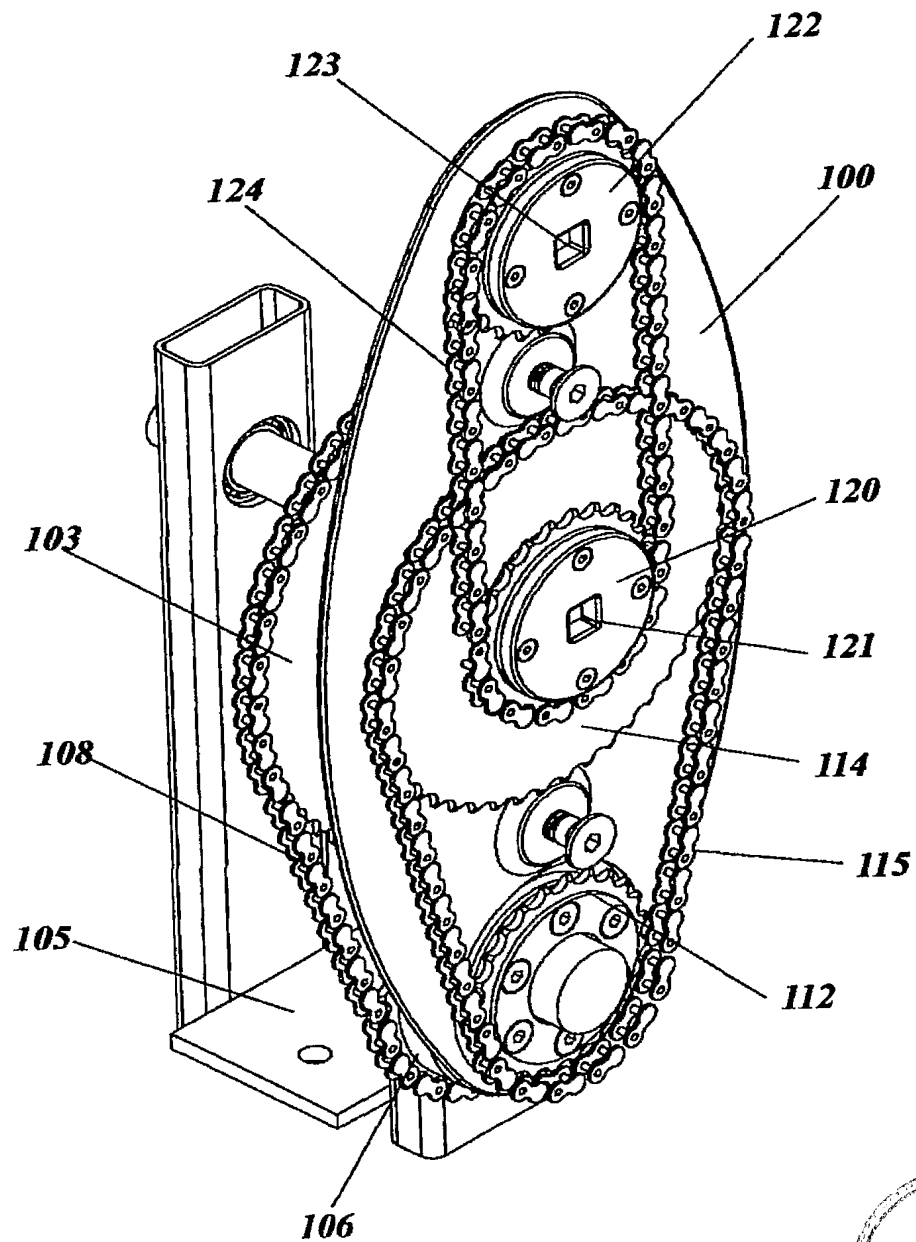
**Fig. 12a**



**Fig. 12b**

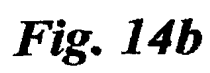
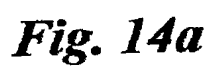


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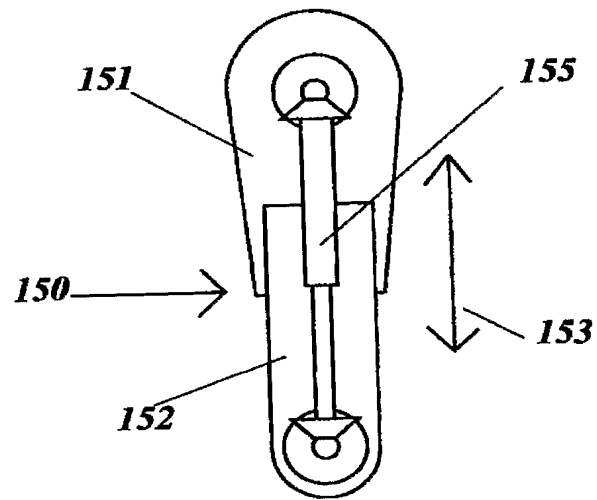


**Fig. 13**

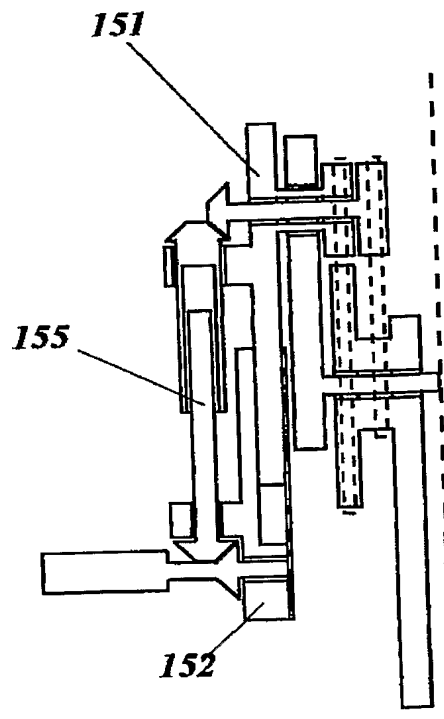




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**Fig. 15a**



**Fig. 15b**



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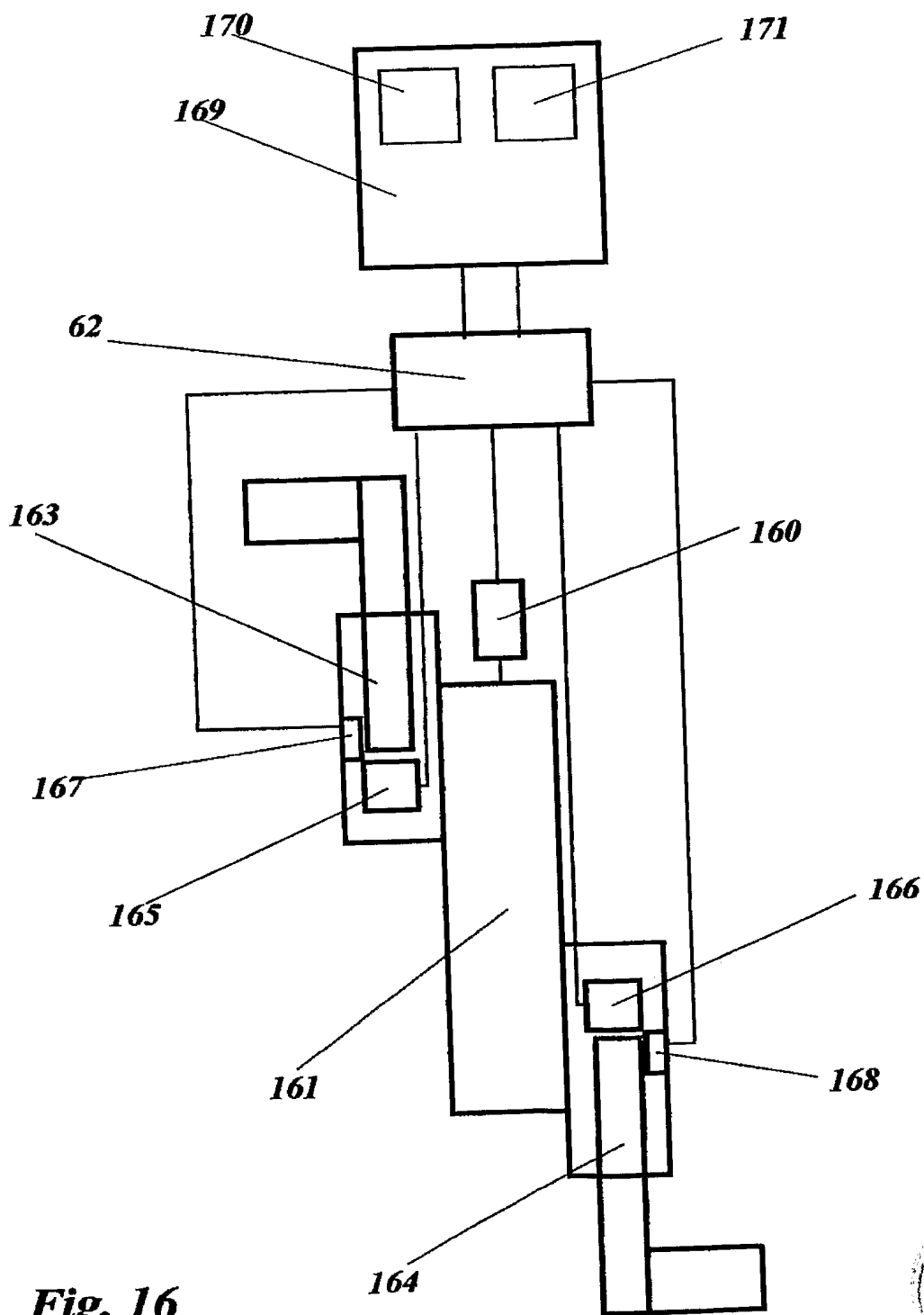
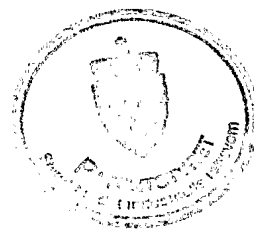
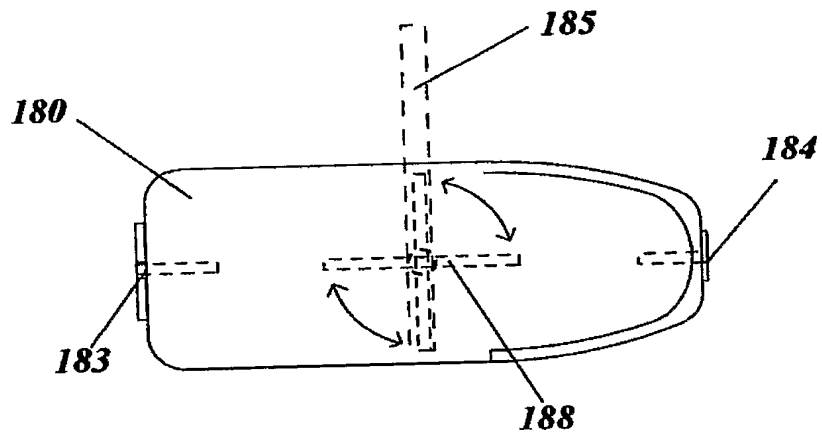


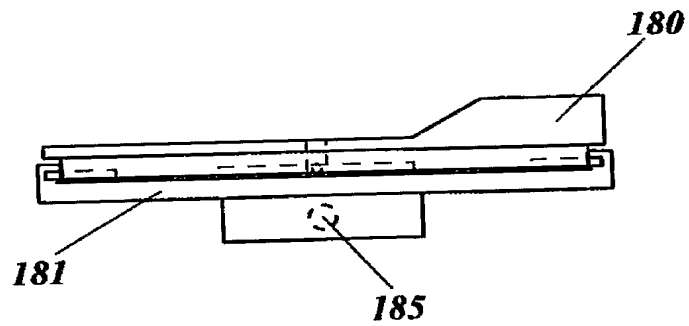
Fig. 16



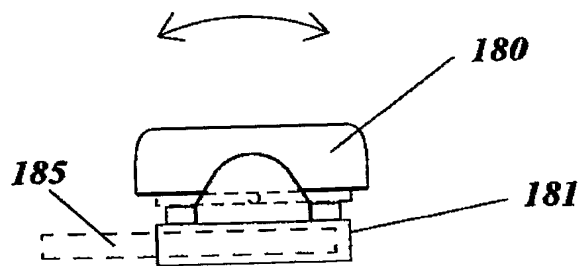
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**Fig. 17a**



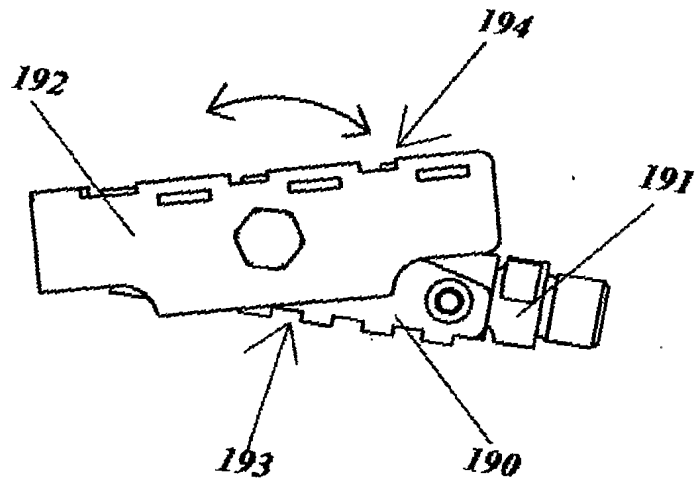
**Fig. 17b**



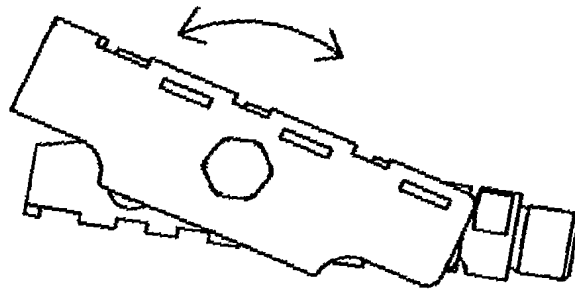
**Fig. 17c**



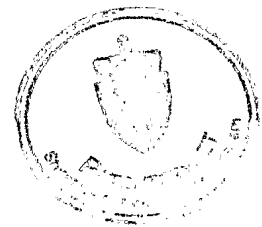
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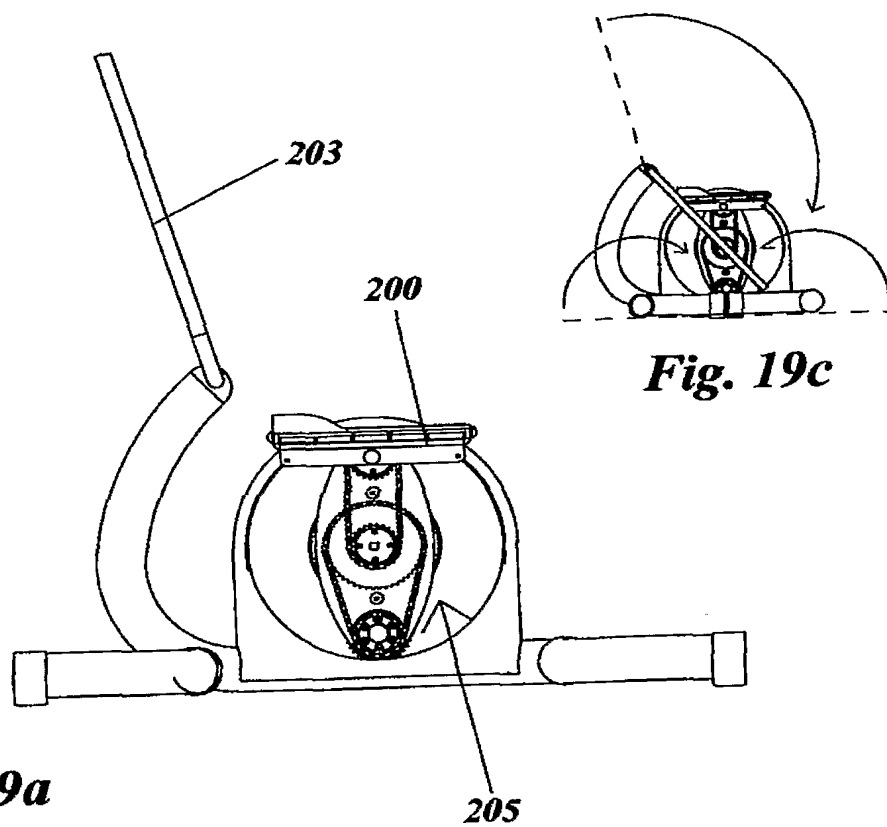
*Fig. 18a*



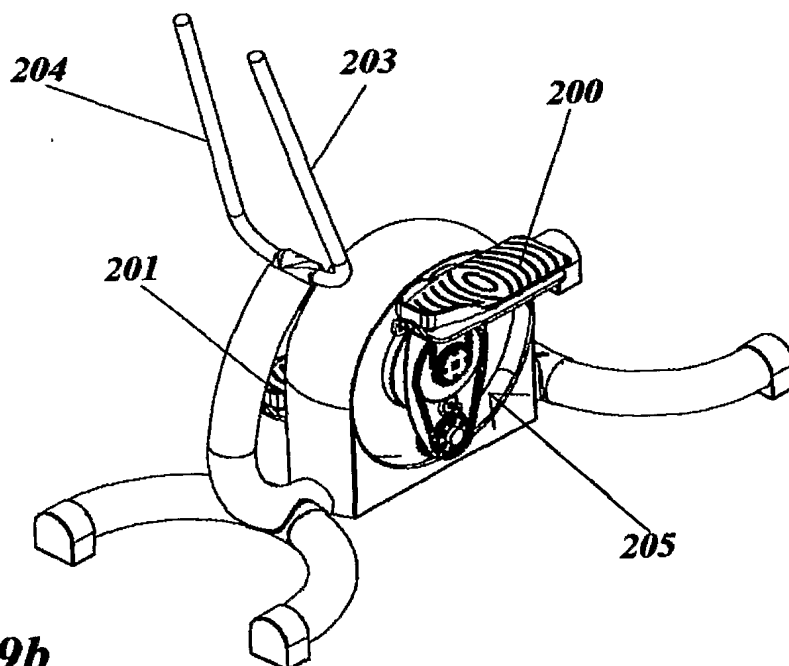
*Fig. 18b*







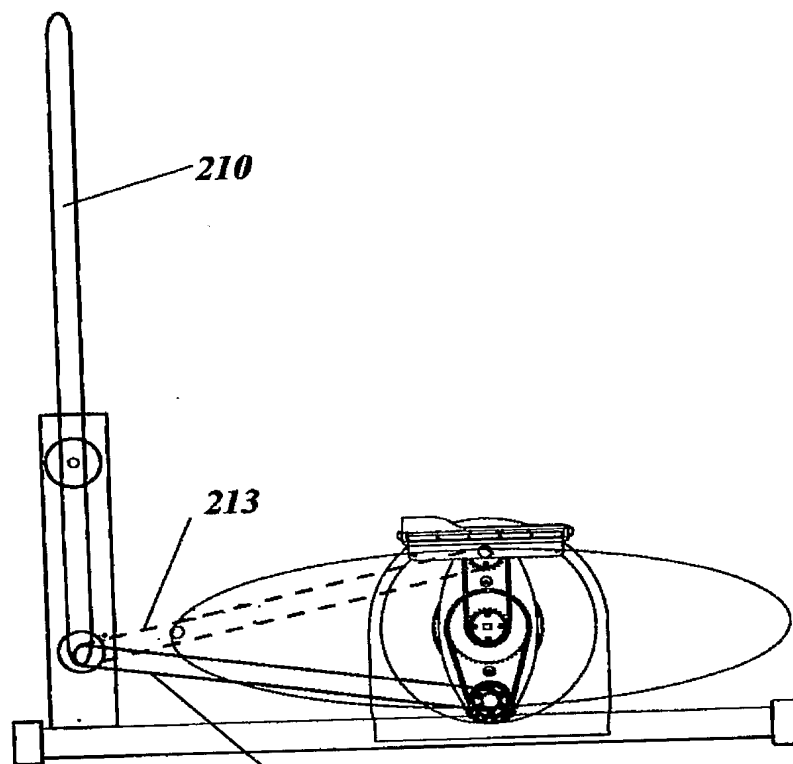
**Fig. 19a**



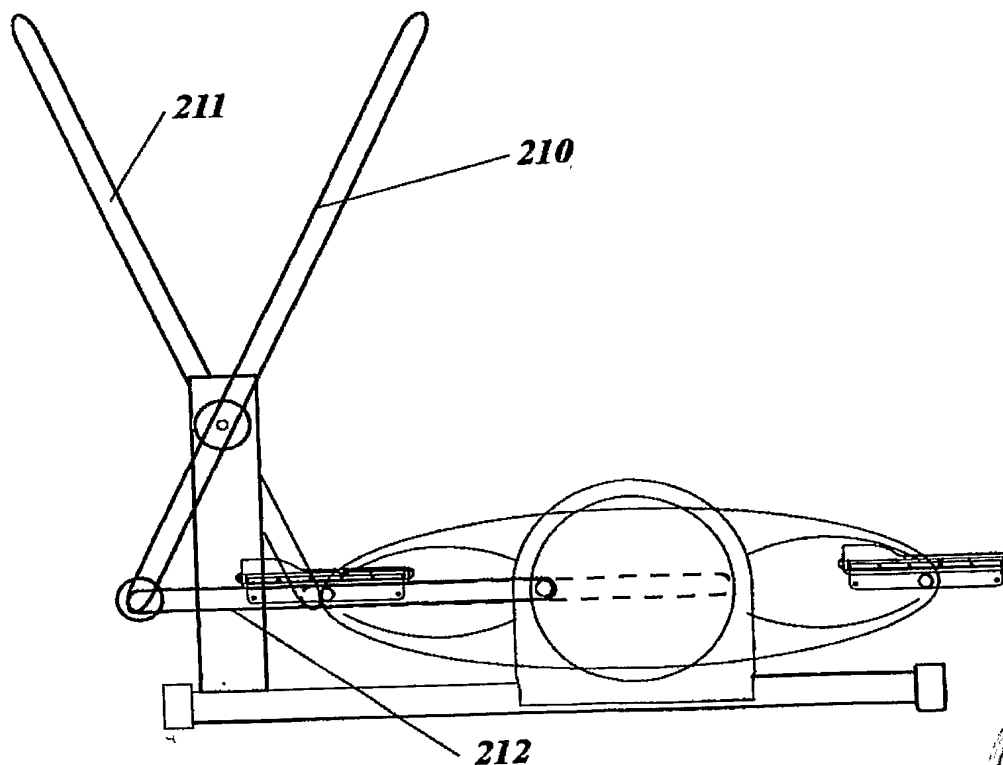
**Fig. 19b**



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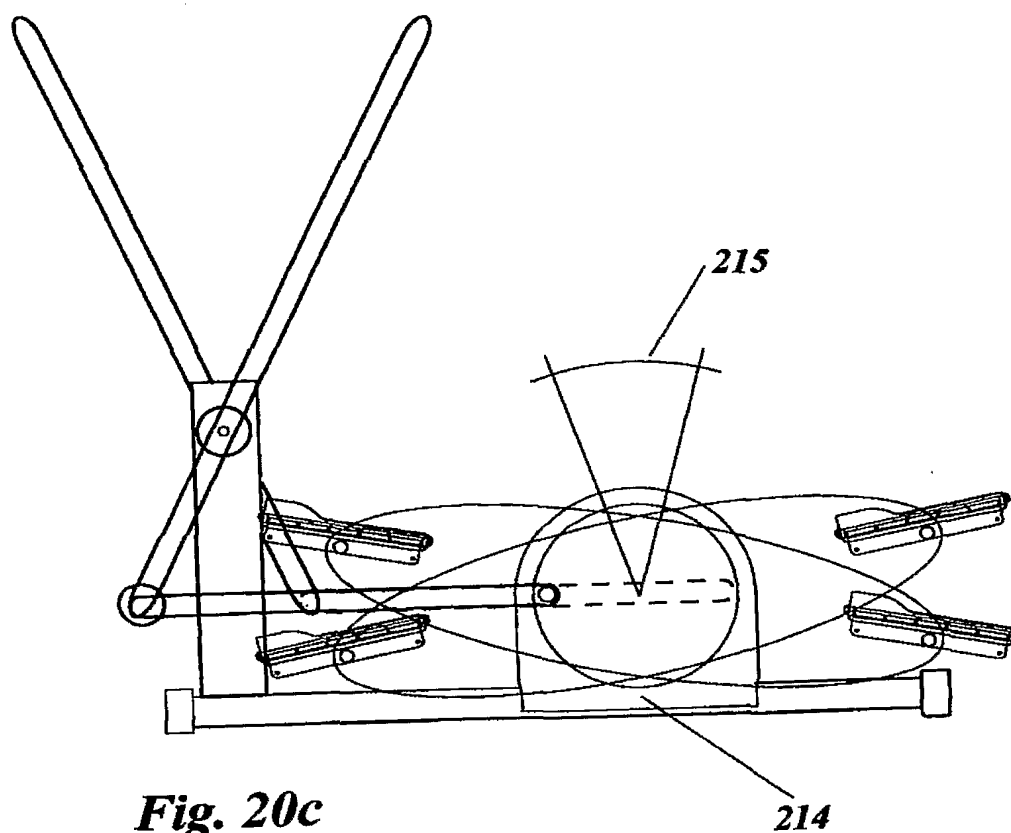


**Fig. 20a**



**Fig. 20b**

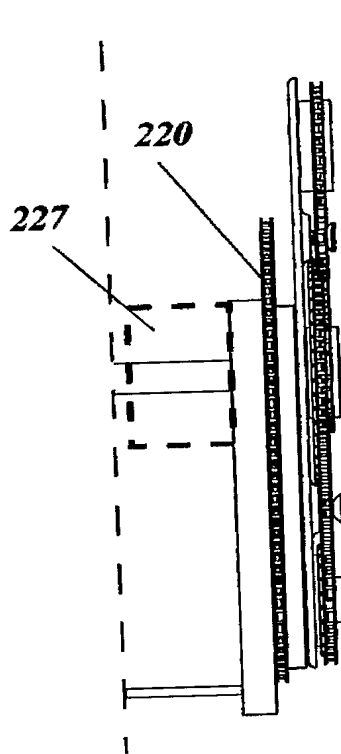




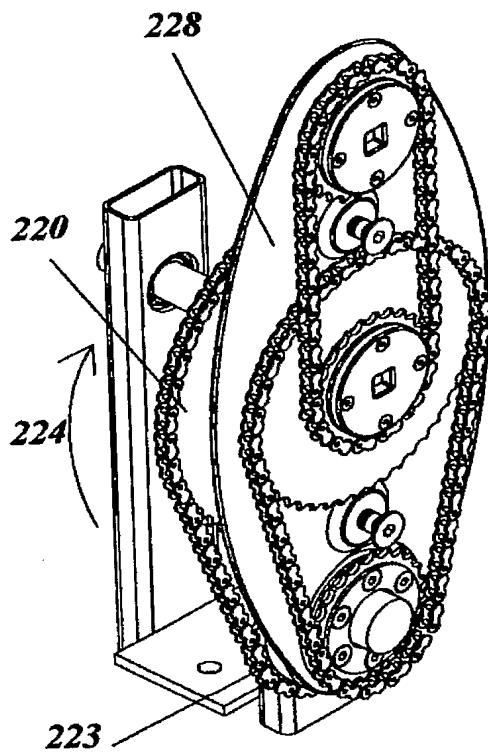
**Fig. 20c**



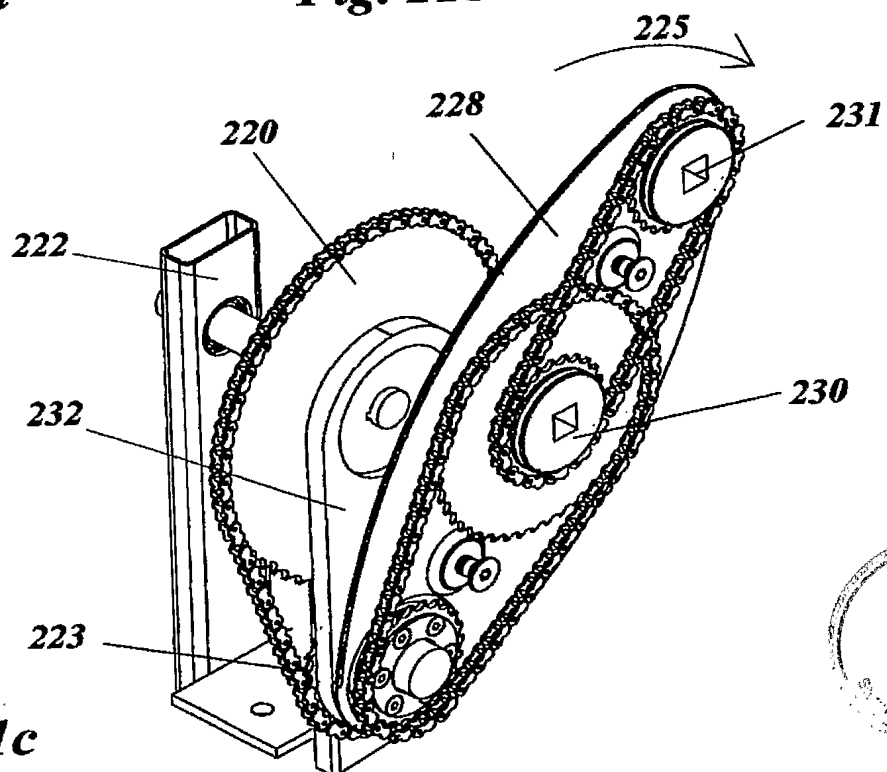
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**Fig. 21a**



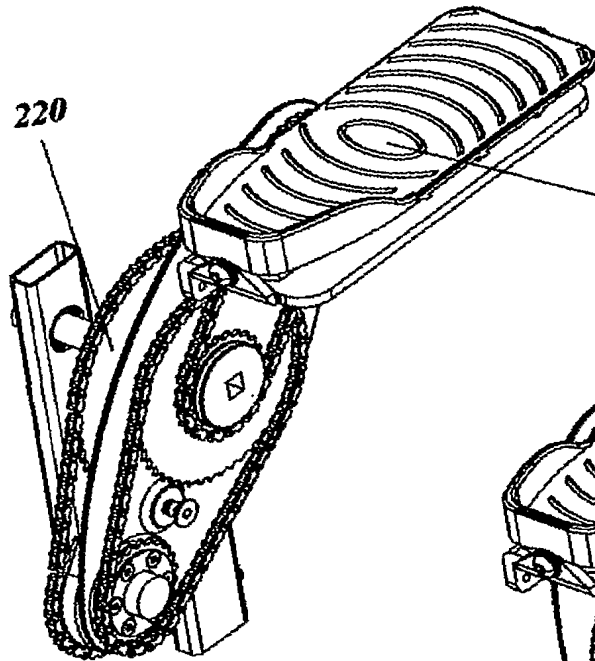
**Fig. 21b**



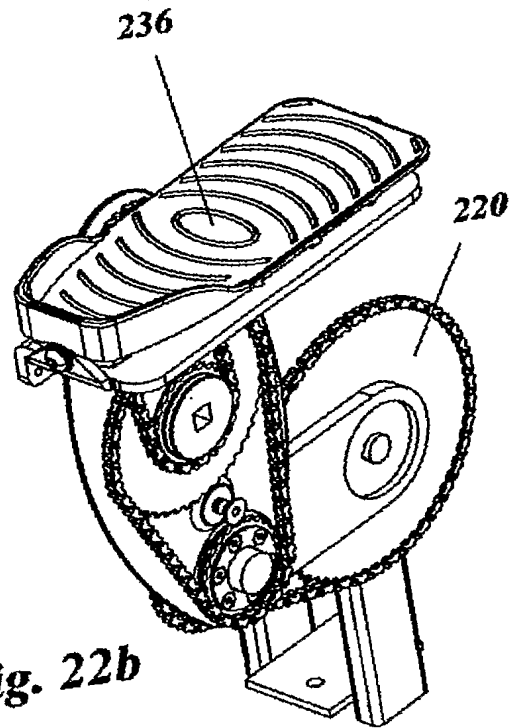
**Fig. 21c**



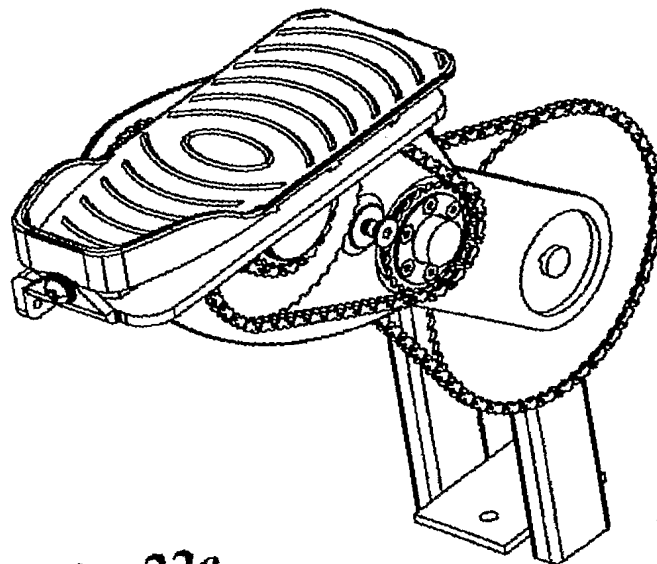
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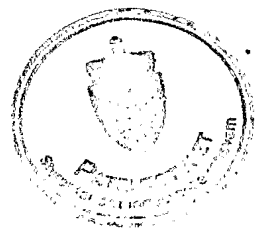
**Fig. 22a**



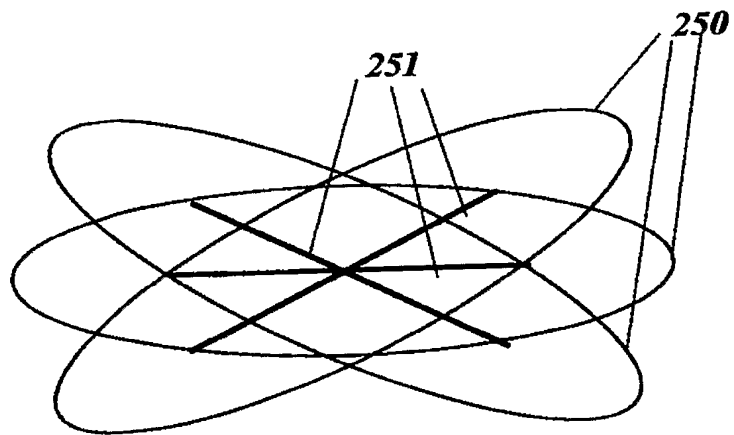
**Fig. 22b**



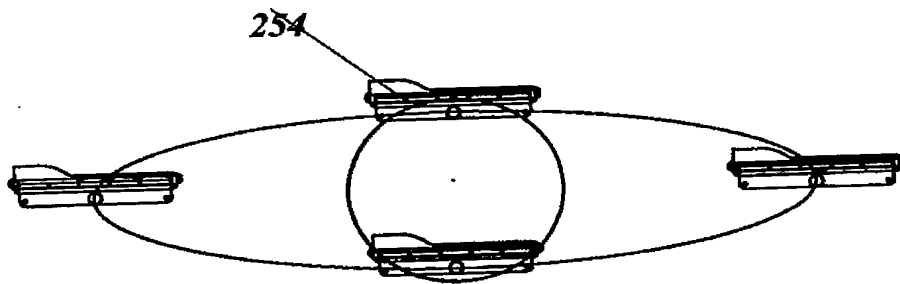
**Fig. 22c**



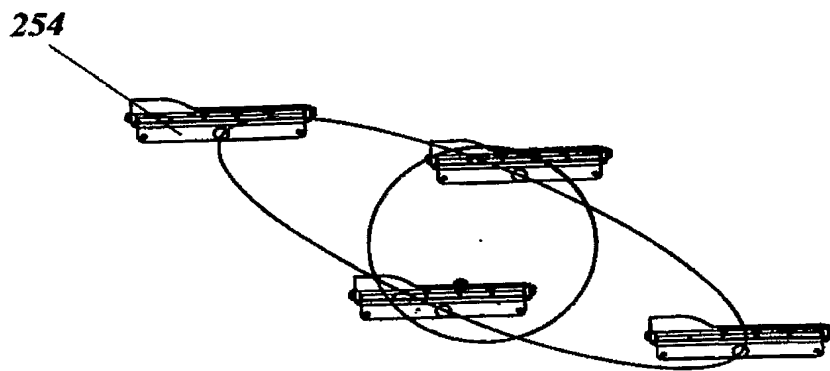
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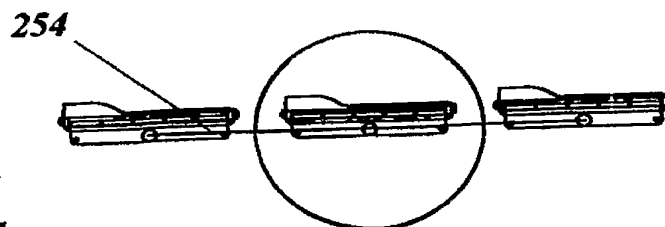
**Fig. 23a**



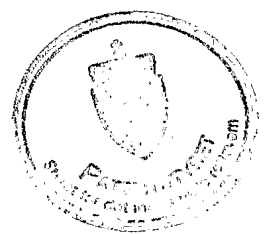
**Fig. 23b**

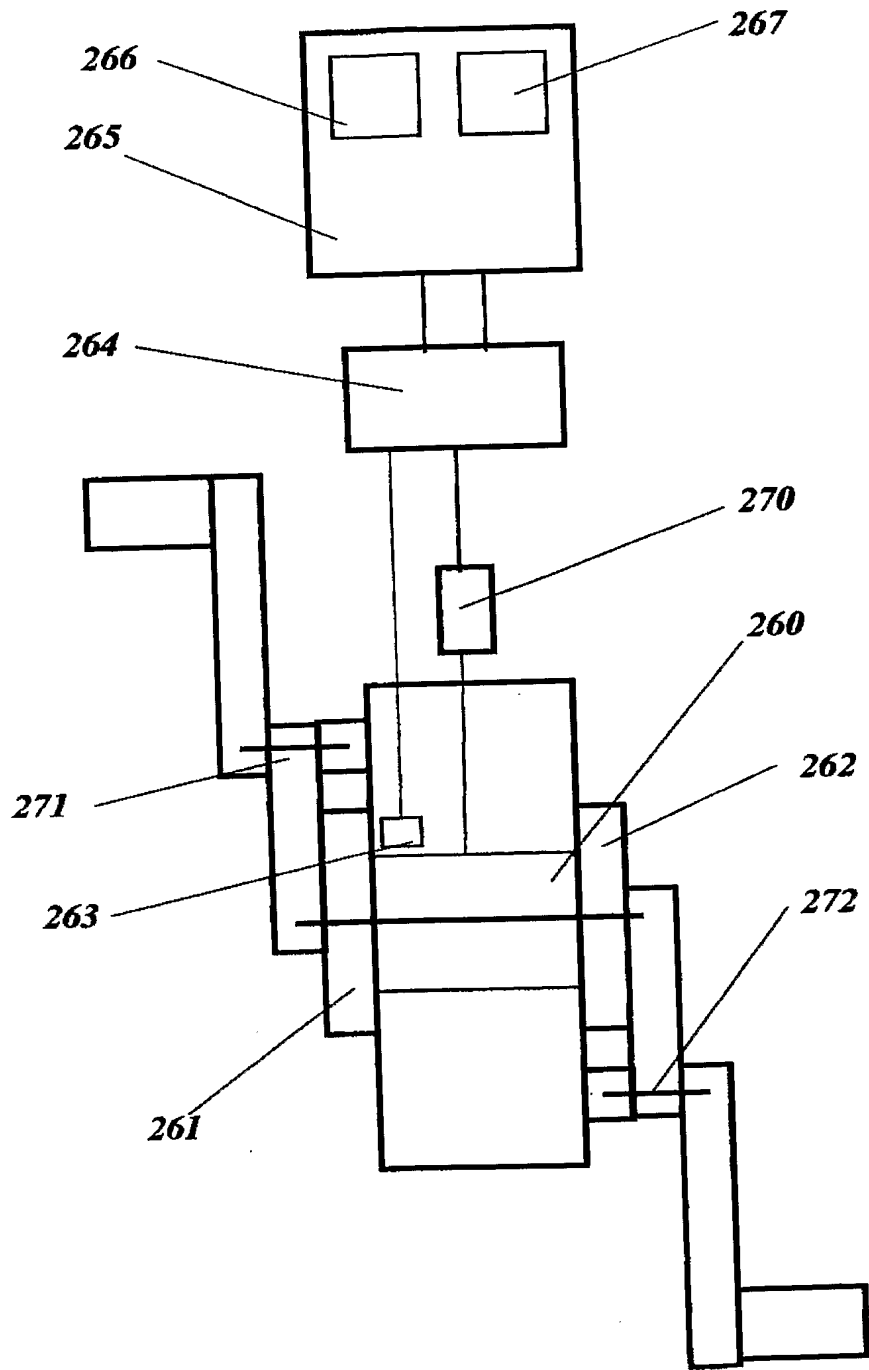


**Fig. 23c**



**Fig. 23d**

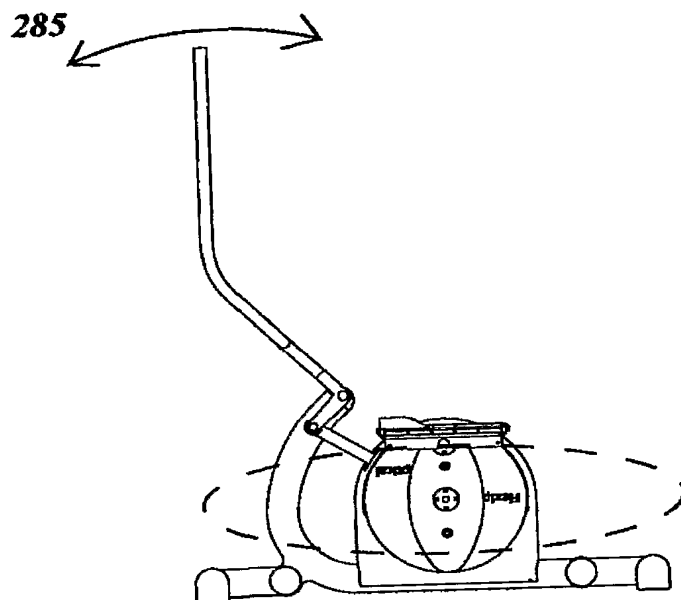




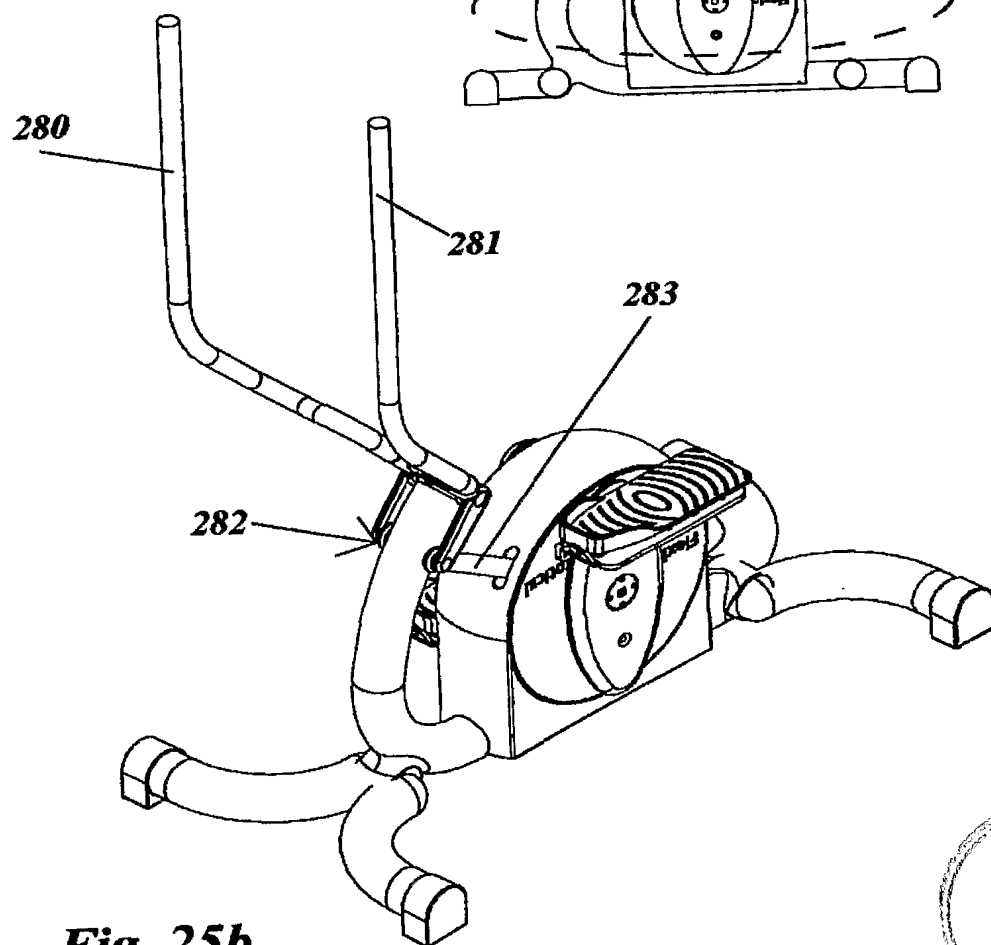
**Fig. 24**



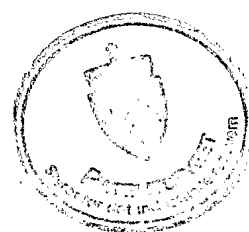
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**Fig. 25a**

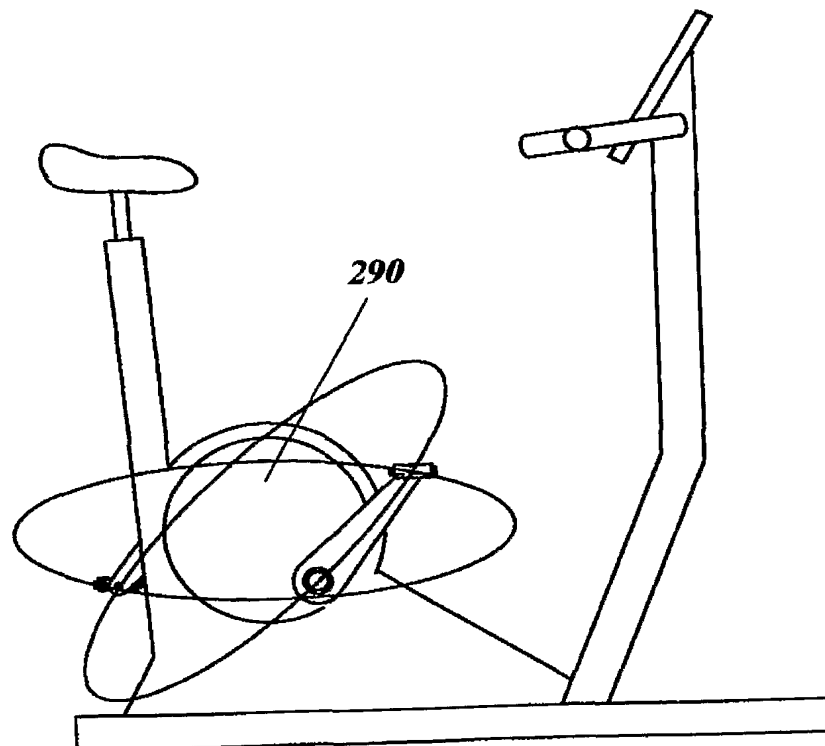


**Fig. 25b**





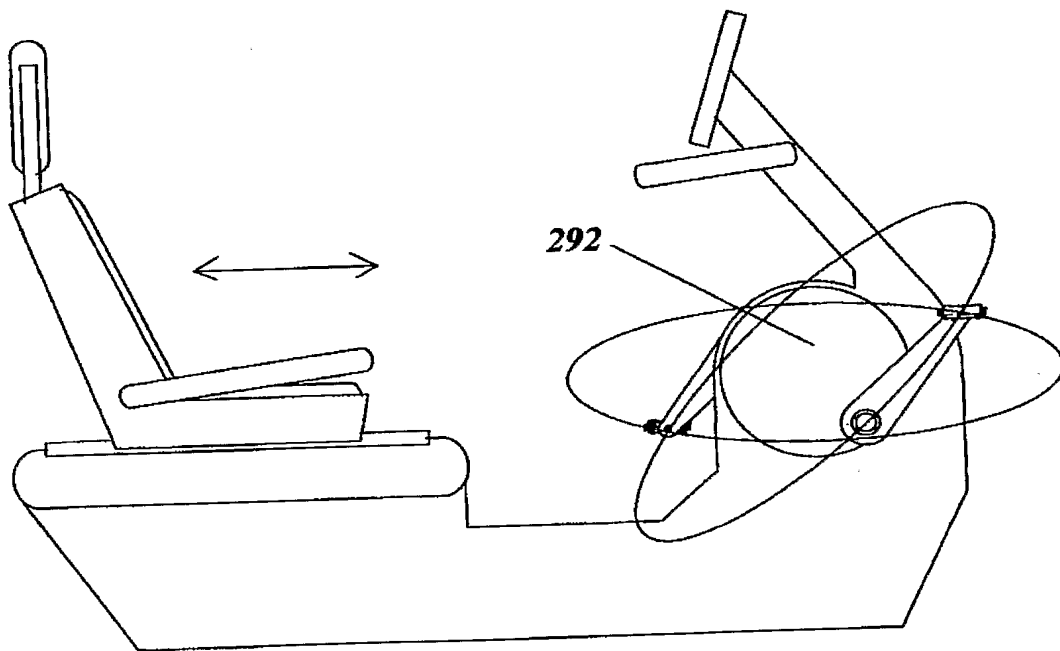
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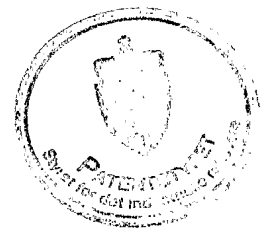
**Fig. 26**



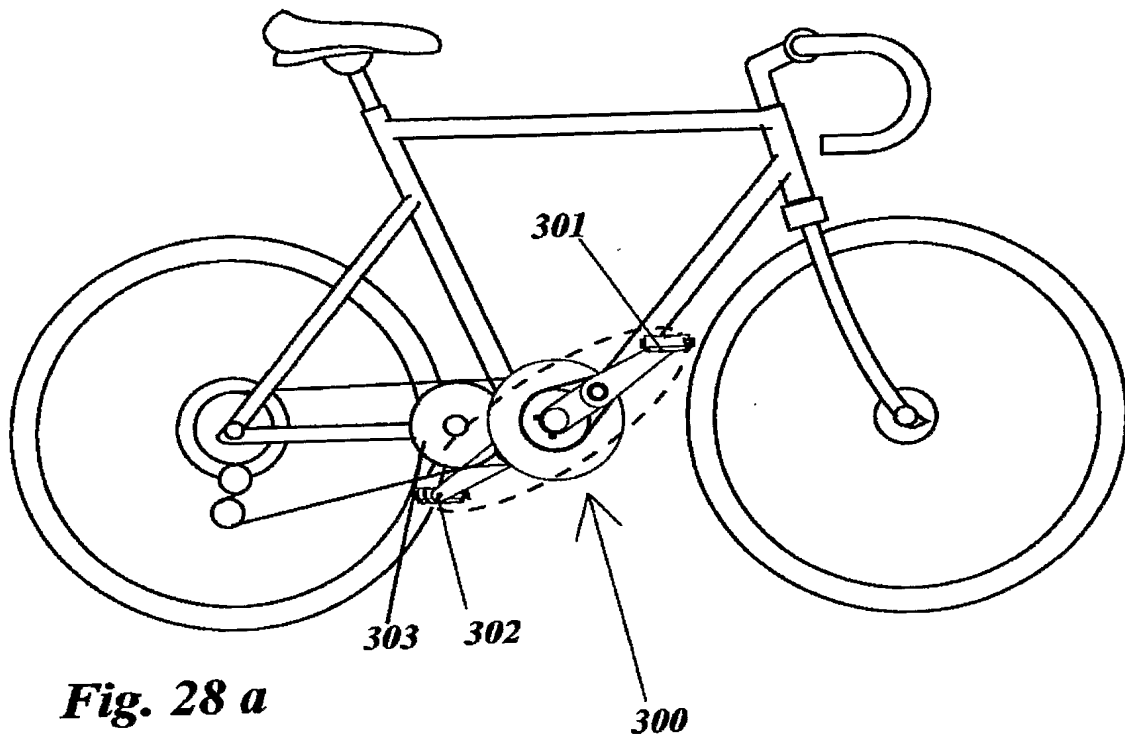
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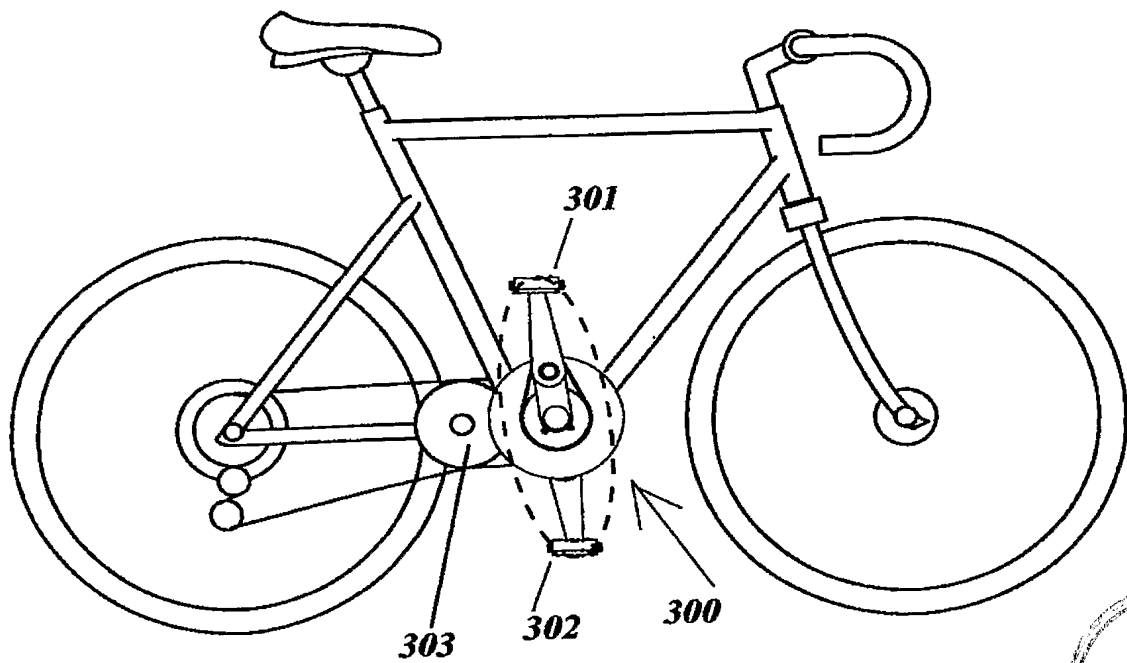
**Fig. 27**



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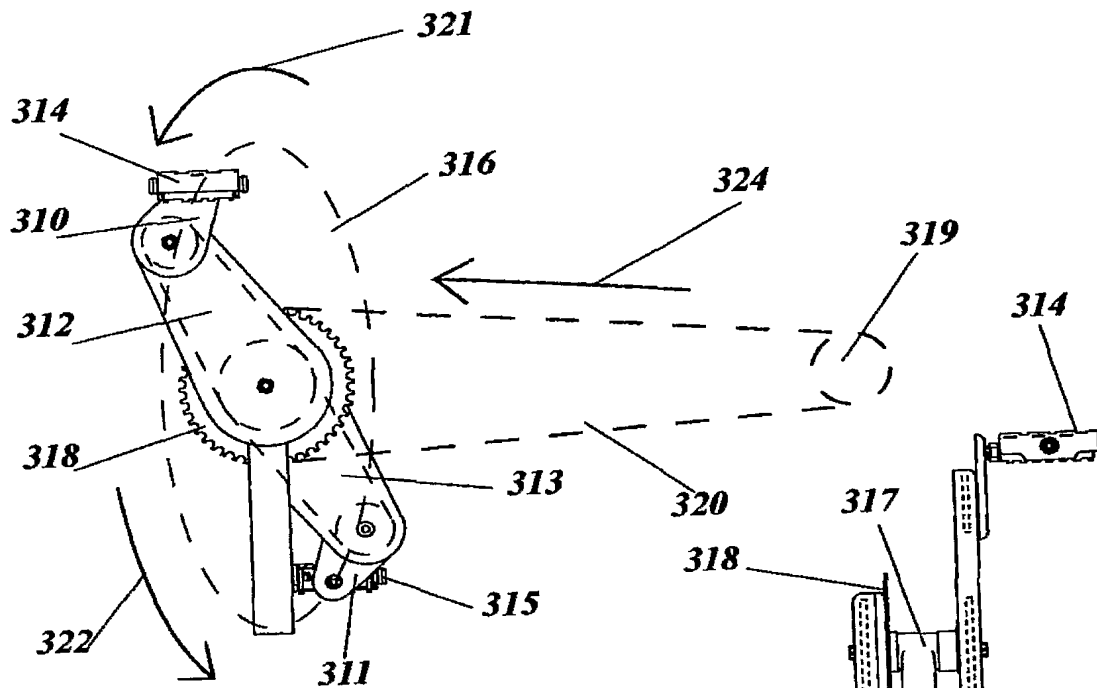
**Fig. 28 a**



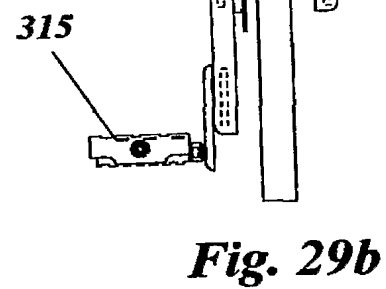
**Fig. 28 b**



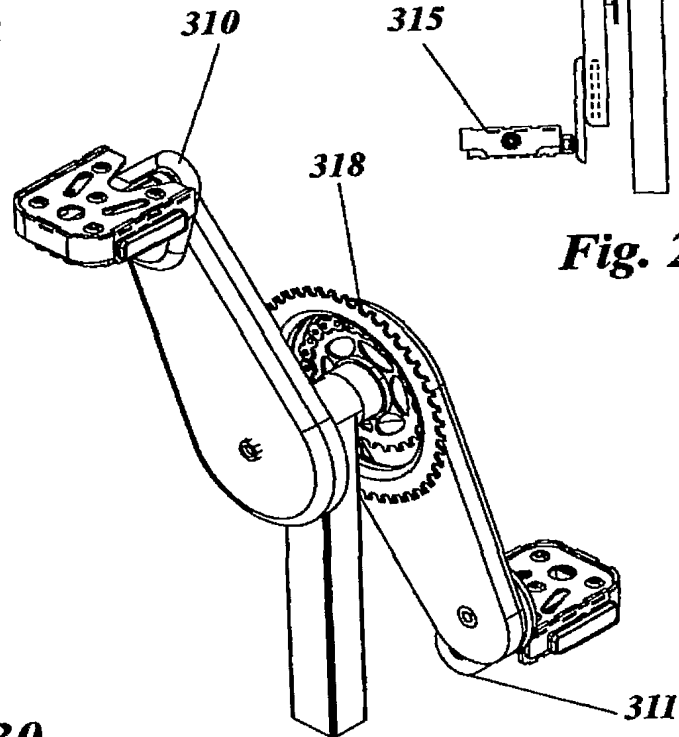
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**Fig. 29a**

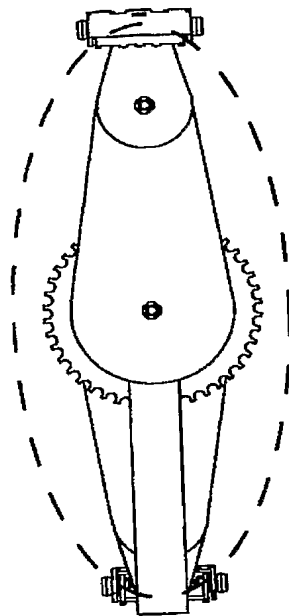


**Fig. 29b**

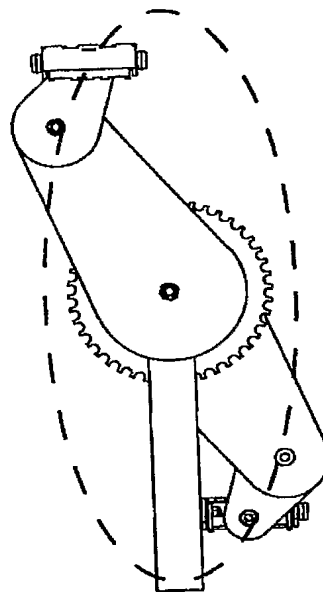


**Fig. 30**

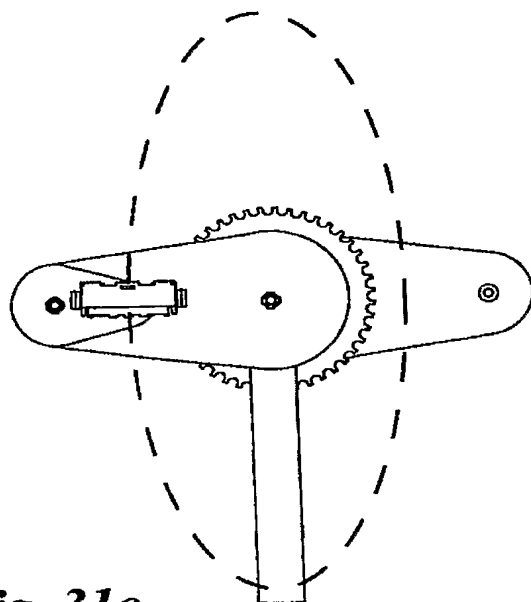




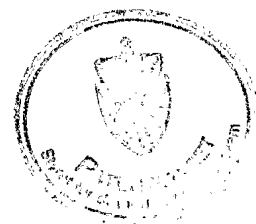
**Fig. 31a**



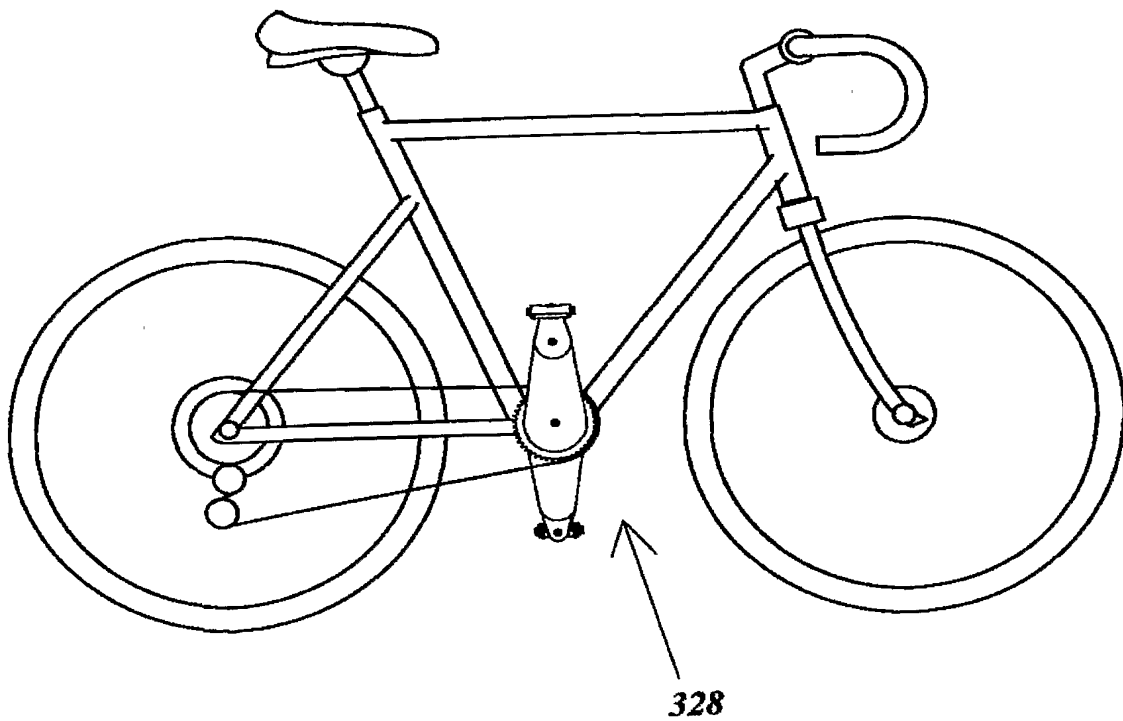
**Fig. 31b**



**Fig. 31c**



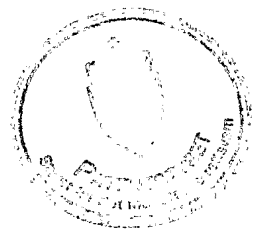
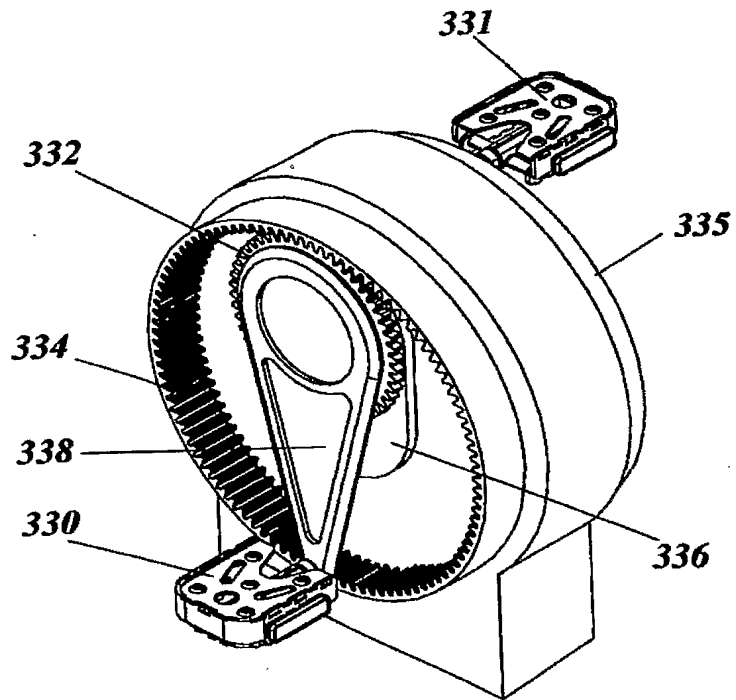
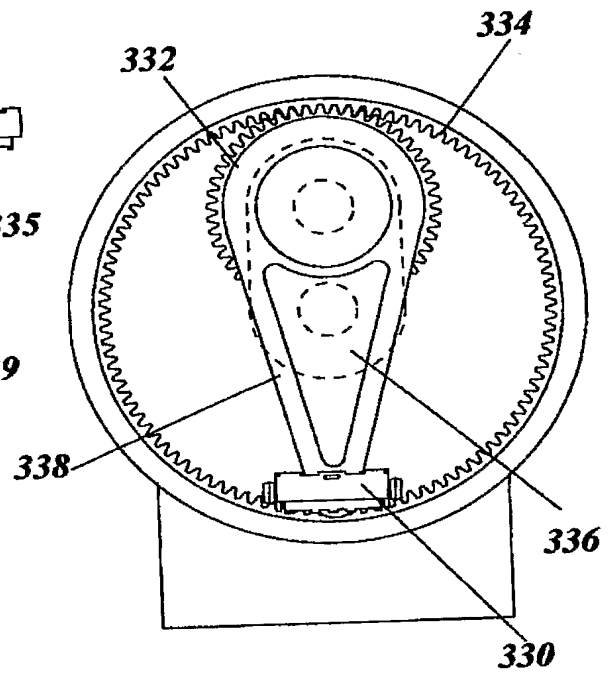
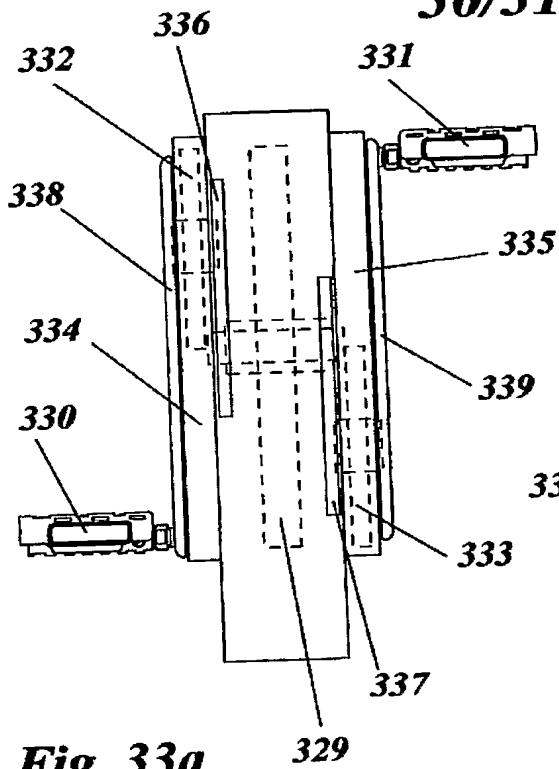
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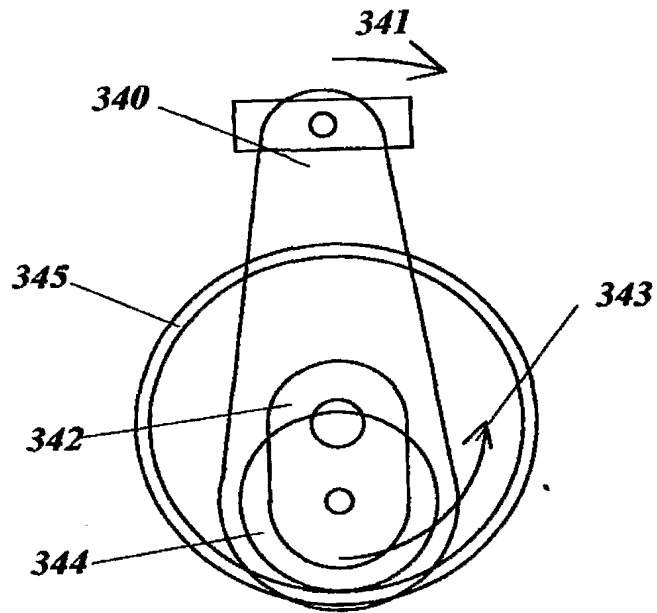
*Fig. 32*



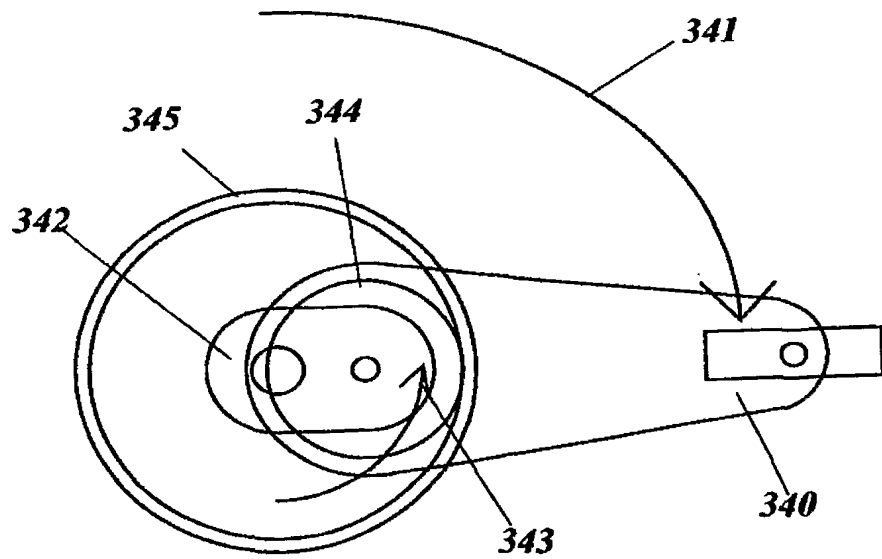
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**Fig 35a**



**Fig 35b**

